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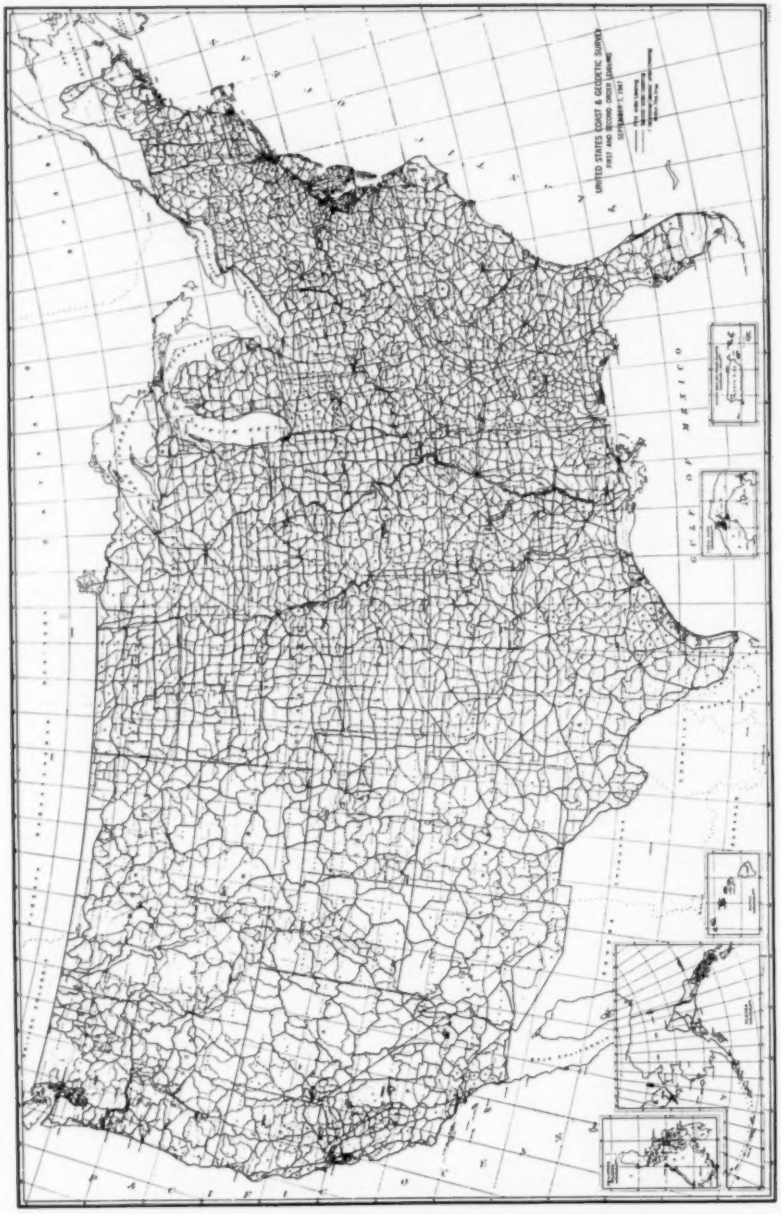

LEVELING NETWORK OF THE UNITED STATES

A network of over 300,000 miles of leveling lines has been established by the Coast and Geodetic Survey. Bench marks, totaling upward of a quarter million, are set at 1-mile intervals along the lines for use in mapping and to furnish elevations for engineering projects.

(See article, "Hitching Our Country to the Stars.")

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Massachusetts Land Court

By LLEWELLYN T. SCHOFIELD
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THE MASSACHUSETTS system of land registration is based upon the so-called Torrens system of Australia.

The word Torrens, used in describing land registration, is a generic term by which practically all land registration systems are known in English speaking countries throughout the world. The Torrens system comes from the South Australian Statute of 1858 and is a monument to the genius of Sir Robert Richard Torrens, Premier and first Registrar General of the Colony.

In 1898 the Massachusetts Registration Act was passed and took effect October 1. This Act, which may be found in Chapter 562 of the acts of that year, provided for a Court of Registration with a judge, an associate judge, and a recorder as an administrative officer.

The purpose of the Act was to create a system of dealing with land which was simple, rapid, inexpensive, and secure. At the time the Act was passed, there were in this Commonwealth, and now are, 21 registries of deeds located in the 14 counties. The new registration system was grafted to the existing machinery by establishing a Land Court Section in each Registry and making each registrar of deeds an exofficio assistant recorder of the Court. The statute provided that all original registration proceedings should be handled by the Court of Registration sitting in Boston, with power to adjourn elsewhere as public convenience might require. After a decree of the Court had been issued and forwarded to the assistant recorder in the district where the land was located, it would be transcribed into a book as an original Certificate of Title and a Duplicate Certificate furnished the owner of the land. A certificate contained the following information:

1. The number of the certificate in that particular registry.
2. Name and address of the owner.
3. Description of the land with reference to a plan filed either with the certificate, or some other certificate in the same registry. The locus was fixed in detail on the plan and generalized as a bounding rather than a running description.
4. All appurtenant rights and encumbrances as decreed by the Court were set forth.
5. On the back, all conveyances, mortgages, easements, liens, etc., pertaining to the land were recorded.

All transactions with reference to registered land were handled by the local registry unless specific directions were necessary from the Court. When a parcel of registered land was to be subdivided, a new plan was required showing such data as the Court might order. This plan was forwarded to the local registry with authorization thereon for the assistant recorder to issue a new certificate for the new lot and to cancel the grantor's certificate to that parcel.

In 1904, by Chapter 448, the Court was changed to its present name, the "Land Court," and its jurisdiction was enlarged to include the following:

1. Writs of entry.
2. Petitions to require action to try title to real estate.
3. Petitions to determine the validity of encumbrances.
4. Petitions to discharge old mortgages.

Since 1904 the following additions have been made to the jurisdiction of the Court:

1. Petitions to foreclose tax titles.
2. Petitions to establish power or authority to transfer an interest in real estate.
3. Petitions to determine the boundaries of flats.
4. Petitions to determine whether or not equitable restrictions are enforceable.
5. Petitions to determine county, city, town or district boundaries.
6. Petitions to determine the validity of zoning laws, etc.
7. All equity actions affecting land, except those relating to specific performance of contracts.

Thus, by successive steps of legislation since the original act was passed, the Land Court has been given jurisdiction over practically all actions affecting the title of land.

Originally the Court was one of inferior jurisdiction, and to its orders and decrees an appeal could be taken to the Superior Court. However, the acts of 1899 provided, by chapter 131, that questions of law should be taken directly to the Supreme Judicial Court. This legislation marked the initial step in the emancipation of the Court from the supervision and control of the Superior Court. Now, when a jury trial is demanded, the issues are framed in the Land Court and the arguments upon these issues are tried before a jury in the Superior Court. With the adjudication of the questions of fact, the work in the Land Court proceeds, and the ultimate decision is in no way amenable to the machinery of the Superior Court. A petitioner for registration in the Land Court has a constitutional right to demand a jury trial, but this right is seldom exercised. Therefore, intrusion into the Superior Court for the use of a jury is a rather rare occurrence.

The work of the Court is, in general, divided into two classes of cases—contested and uncontested. Special assignments take the place of the general trial list of the Superior Court. An uncontested case may take more time than a contested case. The duties of the judges do not end, moreover, with the issuance of a decision or a decree. All subsequent conveyances where any unusual questions of procedure are involved, or which involve transfers by a person acting in a fiduciary capacity, are brought to the attention of, and are supervised by, the recorder acting in consultation with a judge.

In 1924 another associate judge was added to the Court so that at present there are three judges of the Land Court—the chief justice and two associates. There are also two deputy recorders, one handling administration, the other as Chief Title Examiner.

The Land Registration Act necessitates an adjudication by the Court of the boundaries as well as the ownership of the premises, and the boundaries so determined remain definite and fixed.

The procedure for registration of land is as follows: A petition setting forth the claim of the petitioner, accompanied by a plan of the property and a certificate signed by the Assessors of Real Estate of the locus setting forth the abutters at the last date of assessment, is filed with the Land Court. The Court appoints an Examiner, who must be an attorney qualified by the Court, to examine the records and report by filing a narrative, opinion, and abstract of, all the records

that he feels are necessary to meet the requirements of law. He may be required to furnish supplemental reports if the Court feels that they are necessary. Upon completion of his report citations are prepared and served on the abutters, and all others who may be affected, by registered mail with return receipt. The land is posted by a deputy sheriff with a copy of the citation, and publication is made for three successive weeks in a newspaper that is circulated in the particular vicinity of the locus.

Thus, all persons are given a chance to be heard and an opportunity to file appearances and answers. In due course the petition reaches the judge's chambers, and after determining the validity of the title by trial or otherwise, he issues an order for a decree setting forth exactly what the petitioner will receive.

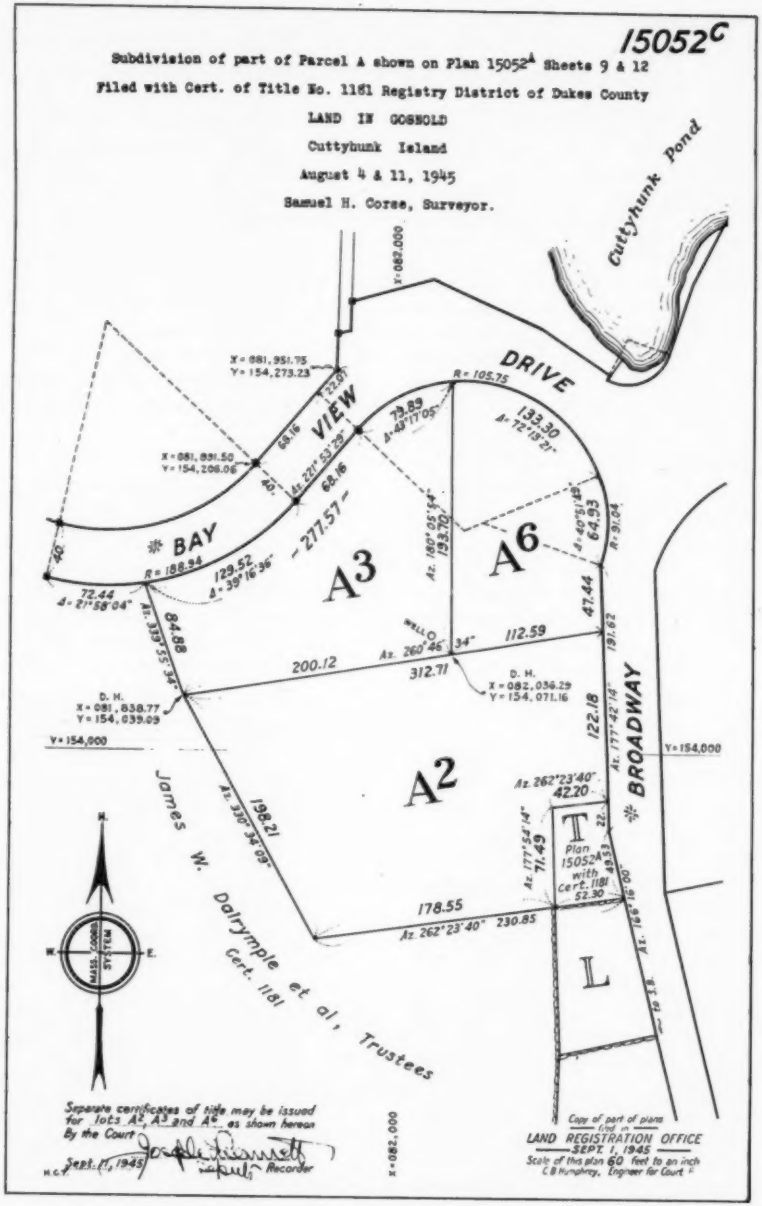
A plan is prepared by the Land Court Engineering Department, and a decree drawn in conformance with the order and plan so prepared. This is returned to the judge for his final initialing and, upon final payment of all fees, the order is sent out to the registry district where the assistant recorder issues a Certificate to the petitioner.

The Land Registration Act does not provide for an Engineer, but the Honorable Charles Thornton Davis, Judge of the Land Court from 1898 to 1936, recognized the necessity of an engineering department to properly make adjudication of boundary lines upon the earth's surface. Judge Davis established the Engineering Department as an adjunct to the Recorder's Department. It is the duty of this department to prepare a "Manual of Instructions for the Survey of Lands and Preparing Plans for the Land Court." The department inspects the plans submitted to see they are made in accordance with the Instructions. The engineer for the Court is called upon to interpret engineering features, to conduct investigations, and to fix the boundaries that may be decreed by the judges.

The manual is issued for the information and guidance of all engineers and surveyors making surveys and plans for the Land Court. This manual may be amended from time to time, and new editions appear about every 5 years, to keep pace with changes in survey practices.

Each plan made for a petitioner to file for registration must have a statement that the survey has been made in accordance with Land Court instructions over the signature of the engineer or surveyor who has supervised the work. (The term *survey* applies not only to the actual field work, but also the preparation of the notes, computations and plans.)

The survey in every case must be an actual survey upon the ground in full detail, showing the facts existing at the time. A closed traverse must be made around the property, either upon the boundary lines, upon transit lines from which the boundary lines are located, or a combination of both. If the survey is upon transit lines, sufficient data must be shown on the plan so that the dimensions of all property lines can be calculated. The survey is not only to secure a plan showing the premises, but is to be made in such a manner that the boundaries as determined by the Court can be relocated on the ground from the data shown on the plan or filed therewith. All plans filed with petitions shall be subject to the approval of the Engineer of the Court, both as to accuracy and manner in which details are established on the ground. All surveys must be made with a transit which has a telescopic line of sight and is kept in proper adjustment to assure accuracy. A steel tape graduated to one one-hundredths


15052C
Subdivision of part of Parcel A shown on Plan 15052A Sheets 9 & 12
Filed with Cert. of Title No. 1181 Registry District of Dukes County
LAND IN GOSNOLD
Cuttyhunk Island
August 4 & 11, 1945
Samuel H. Corse, Surveyor.
Cuttyhunk Pond
DRIVE
VIEW
BAY
BROADWAY
A3
A6
A2
T
L
Plan 15052A with Cert. 1181
James W. Dalrymple et al, Trustees Cert. 1181
Separate certificates of title may be issued for lots A2, A3 and A6 as shown hereon
By the Court
Sept. 11, 1945
Recorder
Copy of part of plan filed in LAND REGISTRATION OFFICE
SEPT 1, 1945
Scale of this plan 60 feet to an inch
C.B Humphrey, Engineer for Court

TYPICAL PLAN PREPARED BY THE MASSACHUSETTS LAND COURT SHOWING SUBDIVISION OF LAND

of a foot must be used, and this tape should be compared frequently with a recognized standard. In making lineal measurements all possibilities of error such as alignment, tension, sag, and temperature should be considered and corrected.

Surveys are classified into one of four classes—*A*, *B*, *C*, and *D*. The surveyor makes the classification, keeping in mind the location, valuation, and purpose of the survey. Class *A* is for city surveys within the city or town proper where extreme accuracy is desired. Frequently in this work the boundary lines are the middle of partition walls and the faces of buildings. The error of closure shall not exceed 1 part in 10,000. Class *B* includes all suburban properties which lie in residential districts adjacent to business districts of cities or towns, and the error of closure of this class shall not exceed 1 part in 8,000. Class *C* is for country surveys and includes properties occupied as country estates which may or may not be subsequently subdivided. The error of closure for class *C* shall not exceed 1 part in 5,000. Class *D* includes farm surveys and all other properties of low value that are distant from the town or city proper. The error of closure shall not exceed 1 part in 3,000.

The full width of all ways must be shown on the plan and the words "private" or "public" noted thereon. The survey should show the initial monuments used to fix ways and should be connected to these monuments. In the case of private ways without monuments, it is recommended that monuments be set at angle points, or at the beginning and end of curves, and connected to the survey.

Surveys adjacent to railroads should be made so that the monumented railroad base line can be included as a part of the traverse, and so that the side line location of record may be shown as the property lines. To save time and litigation it is advisable to have the plan approved by the railroad engineers before filing it with the Court.

It is important that the surveyor ascertain in advance whether or not the property to be surveyed is adjacent to, or in the immediate vicinity of, previously registered land. He should use the boundary lines established by the Court; the same system of bearings; and the same coordinate system if one has been established, unless the new survey is connected with the Massachusetts Coordinate System. Surveyors for the Court should ascertain the location of control monuments established by the Massachusetts Geodetic Survey so that any survey within 500 feet of such a control point may be connected to the Massachusetts Coordinate System. The name of the station, the *X* and *Y* coordinates, and azimuth or grid bearing of the sighting station should be shown on the plan or filed as a separate sketch.

There should be two or more permanent monuments upon or near each locus, and these monuments should be connected in such a manner that they could be used at any future time to relocate the property lines as determined by the Court. Bronze disks for use in concrete or stone bounds may be purchased from the Court. These disks may also be used in drill holes in boulders, ledges, sidewalks, walls, etc. Stone or concrete bounds should be about 6 inches square and about 3–1/2 feet long, and should be set in the ground in such a manner that displacement will not take place due to frost action, erosion, or traffic abuse.

In making plans for the Court the following pertinent facts must be kept in mind in order to comply with the Manual of Instructions:

1. The plan must be made on tracing cloth.

2. The size must be 18 by 24 inches or 24 by 36 inches, or if larger than these dimensions any convenient size may be used.

3. The title must state the location, scale, date, name, and address of the engineer or surveyor.

4. The plan must show the north point, the area, town or county lines, names of adjoining owners, passageways, street lines, boundary monuments, all fences, walls, buildings on the locus or adjacent to the lines claimed, and all other natural monuments pertinent to the purpose.

5. The scale must be such as to show clearly all necessary data.

6. The area may be determined by calculation or by scale, and if by scale the plus or minus sign must be affixed.

7. The parts of all buildings and other physical features on adjoining land which are located within 10 feet of boundary lines must be shown.

8. The boundaries of the property, dimensions, and all physical features pertinent to the location, must be drawn in black, and all traverse and surveying data should be indicated in red.

9. The plan must plainly indicate the manner in which each corner, property line, and reference point is marked upon the ground. This information is very essential, because respondents often object to a plan and survey because a stone bound, partition wall, retaining wall, or other object used to mark a boundary, has been erroneously included or excluded. For this reason, a careful inquiry should be made to determine the ownership of such monuments. If necessary, a note on the plan should state what part of the monument was used, for example, a line through the middle of a brick wall, the face of a wall on line, etc.

10. The property should be oriented on the plan in such a manner that the top is in a general northerly direction. The locus sought to be registered must be enclosed in a blue tint. In the case of water boundaries, and blue is used for water, the locus may be outlined with a green tint.

A plan is prepared by the Engineering Department on the same or a reduced scale, and this plan as modified by the Court order accompanies every decree issued. Whenever a parcel of registered land is subdivided and conveyed, the Engineering Department prepares a plan to show the extent of such conveyance. This plan, if very simple, will be prepared by the Engineer of the Court. If involved, however, it must be made by a surveyor in accordance with the Manual of Instructions and a reduced copy is made by the Engineering Department and forwarded to the Registry District with authority to issue a new Certificate. With over 21,000 decree plans in the Court subject to subdivision, this work has been increasing so rapidly that it has created a considerable backlog of work for the Engineering Department.

The registration fees were increased in 1923 by the additional charge of one-quarter of 1 percent of the assessed valuation but a total of not less than ten nor over a thousand dollars. In 1946 the fees were further increased.

A rough estimate of the cost of registering the title to a house lot assessed for a thousand dollars would be: 75 dollars for the survey and plan, 75 dollars for attorney's fee, 75 dollars for examination of title and 50 dollars to cover statutory and incidental fees, for a total of 275 dollars.

The Registration Act provides that under certain circumstances, "A person who, without negligence on his part, sustains loss or damage, or is deprived of land or of any estate or interest therein after the original registration of land,

by the registration of another person as owner of such land or of any estate or interest therein, through fraud or in consequence of an error, omission, mistake or misdescription in any certificate of title or in any entry or memorandum in the registration book, may recover in contract in the Superior Court compensation for such loss or damage or for such land or estate or interest therein from the assurance fund." This fund is provided for by a charge of one-tenth of 1 percent of the assessed valuation of the property, such fee to be collected both upon original registration and upon the entry of a new certificate after death of a registered owner.

The statute provides that every 3 months the recorder shall turn over to the State Treasurer all fees received in cases which have been completed. In some years these fees have amounted to over 70 percent of the total cost to the Commonwealth of the Court's operations, the largest return being $74,194.72, received in the year 1926.

Thus, a title acquired under a decree of the Court becomes an indefeasible title, a title that is settled and a title that remains settled.

In the preparation of this paper, the writer is especially indebted to Mr. Clarence B. Humphrey, Engineer for the Court from 1909 to 1946, Mr. William T. Fairclough, the present Engineer, to the judges, and all other employees of the Court with whom he has been associated during the past 11 years.

* * *

Welcome "Garls"!

THE Property Surveys Division of the American Congress on Surveying and Mapping is pleased to note the formation of the Georgia Association of Registered Land Surveyors (G.A.R.L.S.) under the vigorous leadership of Professor Ralph P. Black of Georgia School of Technology.

The G.A.R.L.S. is the first such organization in the United States to join the Congress under group leadership. The Association is dedicated to "the advancement of the public welfare and the professional, social, and economical interests of the registered land surveyor by promotion of education, legislation, and public relations through the establishment and maintenance of high ethical standards and practices," with special emphasis on the improvement of the quality of land surveying performed within its jurisdiction.

The Association has developed and adopted a constitution and by-laws, and, on September 20, 1948, launched its first issue of a monthly bulletin on its activities. Such energy and worthy purpose demands the respect and support of all surveyors throughout the country. The Property Surveys Division congratulates the G.A.R.L.S. on its foresight, its early accomplishments, and its enthusiastic leadership.

S. A. BAUER

A New Device for Solar Observations

By R. ROELOFS

PROFESSOR OF GEODESY AND PHOTOGRAMMETRY AT DELFT, HOLLAND

INTRODUCTION

IT IS a well-known fact that solar observations for determining azimuth, latitude, or longitude are less accurate than star observations. The main causes are: (*a*) The relative inaccuracy of pointing on the limb of the sun, and (*b*) the influence of the sun's heat-radiation on the theodolite.

Inaccuracy of Pointing on Limb of the Sun

As it is impossible to point on the center of the sun, owing to the great size of the sun's disk, it is customary to place the image of the sun in the field of view of the telescope in such a position that it is tangent to:

(1) The vertical wire in the case of a determination of azimuth by hour angle.

(2) The horizontal wire in the case of a determination of longitude by altitude or in the case of a determination of latitude by circummeridian altitude and hour angle.

(3) Both vertical and horizontal wires in the case of a determination of azimuth by altitude.

In cases (1) and (2), the telescope is clamped when the image of the sun occupies a position just prior to tangency, and the time clock is read at the instant when the disk is tangent to the wire. In case (3), the vertical wire is kept continuously on the right or left limb by means of the horizontal tangent screw and this motion is stopped at the instant when the disk is equally tangent to the horizontal wire.

In all cases systematic personal errors may be introduced by a too "thick" or too "thin" tangency of limb(s) and wire(s). The question arises whether it is possible to eliminate these errors by observing opposite limbs successively and pairing the observations.

This is not true inasmuch as it is preferable to always observe the very limb which appears to *leave* the wire, the latter being poorly visible or non-visible (depending on the clearness of the sky) outside the sun's disk. But even when the wire is passably visible in the dark part of the field of view—due to a veiled sky—the tangency errors may not be expected to be equal for limbs approaching a non-visible or poorly visible wire or leaving a clearly visible wire.

In case (3), where the vertical wire has to be kept continuously tangent to the disk, the difficulty of this wire being then poorly visible or non-visible is evident. In this case there is a much more serious source of error. The exact pointing of the telescope is attained at the instant when both cross wires are *simultaneously* tangent to the sun's disk. For ascertaining this the observer has to turn his attention to both tangency-points, which are a large distance (approximately 22′) apart. Theoretically he should observe these tangency-points simultaneously, but in practice he can only try to observe them *alternately* as quickly as possible. As a consequence the pointing is uncertain and inaccurate.

Influence of Heat-Radiation on Theodolite

As a direct observation of the sun through the telescope is not possible, due

to the intense light, a colored eyepiece is used, or the image of the sun and the cross wires are brought to a focus on a white piece of paper which is held in the rear of the eyepiece.

The objective lens focuses the untempered rays of sunlight in the plane of the wires or, in modern instruments, cross lines engraved on a glass diaphragm. At the same time, however, that the objective lens focuses the rays of *sunheat*, it operates as a burning glass, causing in the latter type of instruments an extreme heating of the glass diaphragm and—to a lesser extent—of the diaphragm ring, which involves expansion and tension. As, according to the methods of observation described previously, the position of the sun's image in the field of view is eccentric, the center of expansion does not coincide with the center of the diaphragm. This may cause an irregular expansion of the glassplate and diaphragm ring, resulting in a displacement of the point of intersection of the cross lines. The importance of this phenomenon may be evident from the fact that a lateral displacement of only 0.01 millimeter (0.004 inch) produces a lateral or vertical collimation error of 10″ if the length of the telescope is 20 centimeters (8 inches). The position of the sun's image in the field of view not being constant, these collimation errors are also not constant. Therefore, these errors cannot be eliminated completely by repeating the observations with a reversed telescope and taking the mean of the results.

DESCRIPTION OF SOLAR PRISM ATTACHMENT

In order to overcome the difficulties described in the preceding paragraph a special device for solar observations has been designed. (*See* fig. 1.) It consists of a pair of small prisms mounted perpendicular to each other in a short tube (*a*) which has been attached to a collar (*b*) by means of a hinge (*c*). The tube has been closed at the front end by a green filter glass and at the other end by a gray filter glass. The device may be attached in front of the objective of a normal theodolite (figs. 2 and 3), the collar (*b*) fitting over the frame of the objective lens.

In the position shown in figure 2 one of the prisms is in front of the upper half of the objective lens, whereas the other prism is in front of the right-hand half of it (fig. 4). From this it is evident that the first prism is in front of the upper left-hand quadrant of the objective, the second prism is in front of the lower right-hand quadrant, both prisms are in front of the upper right-hand quadrant, and no prism is in front of the lower left-hand quadrant. The effect of this is to produce *four images of the sun*, arranged in a square as shown in figure 5.

The refracting angle of the prisms has been made 23′ 10″ in order to have the four sun's disks overlap each other in pairs, the overlapping parts forming a bright cross (fig. 5). In the center of this cross is a small dark square, ranging from 10″ by 10″ in winter to 75″ by 75″ in summer, depending upon the apparent size of the sun's disk.

The filters produce monochromatic green images of the sun which are comfortable to the observer's eye and reduce the sunlight and sunheat which enter the telescope to a minimum, thus preventing the diaphragm glass and ring from extreme heating.

The target to point at is the bright green cross formed by the overlapping parts of the four sun's images. Pointing on this symmetrical object has several advantages over doing so on a single image of the sun. Among these are:

1. High accuracy—exact pointing being established by observing the wires to bisect the "wings" of the bright cross. (*See* fig. 5.)
2. No personal systematic tangency errors.
3. Wires always clearly visible upon the sun's images.
4. No confusion about the choice of wire-quadrants.
5. Correction of the observed altitude independently of the sun's semidiameter, it being equal to the half of the refracting angle of the prisms.
6. Correction of the observed azimuth independent of the sun's semidiameter,

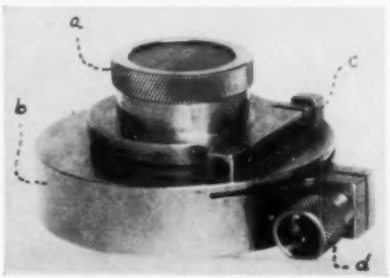


FIGURE 1.—Solar prism attachment.

FIGURE 2.—Solar prism attachment fitted in front of the objective of a Kern theodolite (position when pointing on the sun).

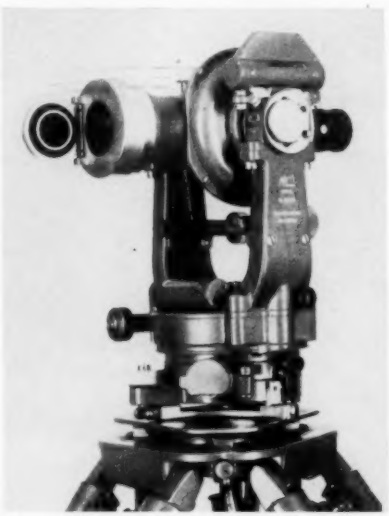


FIGURE 3.—Position of prism attachment when pointing at a ground mark.

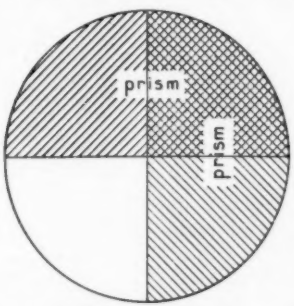


FIGURE 4.—Position of the prisms in front of the objective.

it being equal to the half of the refracting angle of the prisms, divided by the cosine of the observed altitude.

ADJUSTMENT AND USE OF SOLAR PRISM ATTACHMENT

After the prism attachment has been placed over the objective, the telescope is sighted on the sun and the attachment is rotated by hand until the wings of the bright cross, formed by the overlapping parts of the sun's images, are parallel to the wires. The clamp screw (*d*) (fig. 1) is then tightened, thus keeping the attachment in its right position throughout the whole program of observations. It is emphasized that a slight error of this simple adjustment has quite the same effect as lateral and vertical collimation errors and is therefore eliminated by transiting the telescope between successive observations.

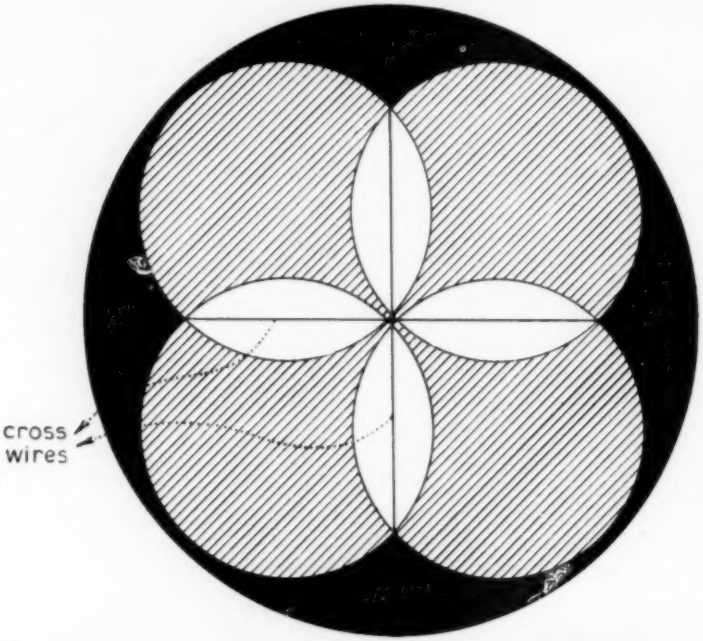


FIGURE 5.—Four images of the sun simultaneously in the field of view of the telescope.

When pointing on the sun the tube containing the prisms and filters is in its normal position in front of the objective (fig. 2). Before pointing on an azimuth-mark the prisms and filters are eliminated by unhinging the tube and swinging it out of the way (fig. 3). As the prisms have been mounted in the tube in a position of minimal deviation, a slight error in the position of the tube, after having replaced it in front of the objective, causes no appreciable effect in the results of the observations.

PROCEDURES AND ACCURACY

In order to examine the accuracy obtainable by applying the new device, the K. L. M. surveyor, Mr. P. deWith, in charge of supplying ground control for a photogrammetric survey of Dutch Guiana (latitude 5° 49′ N, longitude 55° 09′ W), made a number of observations at my request. The procedures and results are described below:

a. Azimuth by altitude of the sun.—The schedule of observations was as follows:

1. Pointing on the ground mark (steeple) and reading the horizontal circle.
2. Pointing on the sun and reading horizontal and vertical circles.
3. Same as 2.
4. Same as 1.

This series of observations was repeated four times; the telescope was reversed between the second and third series. Between each two successive series the horizontal circle was rotated 45° with a view to eliminating systematic circle graduation errors. No striding level being available, the theodolite (a Wild type T2) was leveled carefully before *each* series, the effect of leveling errors thus having the character of random errors. Each *half* series (to be called a *single observation*) was computed separately. From the eight values of the azimuth thus obtained the mean value and the mean error as well as the mean error of a single observation were derived.

The observations according to this schedule were repeated five times. Table 1 shows the results.

TABLE 1.—*Azimuth by altitude of the sun*

Date of observation (1947)	Computed azimuth	Mean error of a single observation	Mean error of the computed azimuth
1–21 p.m.	234° 54′ 2″.9	5″.9	2″.0
1–22 p.m.	7″.3	4″.3	1″.5
1–23 a.m.	10″.1	5″.1	1″.8
1–24 a.m.	4″.5	4″.0	1″.4
1–24 p.m.	5″.8	6″.5	2″.3
Final mean	234° 54′ 6″.1	5″.2	1″.8

Obviously the mean *internal* error of a computed azimuth is 1″.8, on an average. The mean *external* error may be derived by comparing the azimuths with the final mean, shown in table 1, which turns out to be 2″.8. The difference between the internal and external accuracy may be attributed to systematic errors of the astronomical refraction and errors of setting up the theodolite over the stake.

Executing the schedule of four series (eight single observations) required 32 minutes on an average, i.e., 4 minutes per single observation.

b. Azimuth by hour angle of the sun.—The schedule of observations was much the same as described above with one difference, that a time clock was read instead of the vertical circle. Table 2 shows the results of four sets of observations.

TABLE 2.—*Azimuth by hour angle of the sun.*

Date of observation (1947)	Computed azimuth	Mean error of a single observation	Mean error of the computed azimuth
2–25 p.m.	234° 54′ 4″.9	5″.5	1″.9
2–26 p.m.	10″.2	4″.7	1″.7
2–28 a.m.	9″.3	5″.3	1″.9
2–28 p.m.	4″.6	4″.0	1″.4
Final mean	234° 54′ 7″.2	4″.9	1″.7

The mean *external* error of a computed azimuth, derived by a comparison of the azimuth with the final mean, is 2″.9.

The difference between this value and the mean *internal* error (1″.7) may be attributed to errors of the time clock and errors of setting up the theodolite over the stake. Some errors may be introduced also due to the circumstance that the corrections to the time signals were not yet known when the observations were computed. The time required for the execution of the complete schedule was 28 minutes on an average, i.e., 3.5 minutes per single observation.

c. Azimuth by hour angle of stars.—In order to have another check on the results from the solar observations the azimuth was determined twice by star observations (without using the attachment of course). The schedule of observations was similar to the schedule used for the solar observations. Table 3 shows the results.

TABLE 3.—*Azimuth by hour angle of stars*

Date of observation (1947)	Star	Computed azimuth	Mean error of a single observation	Mean error of the computed azimuth
5–12	α Ophiuchi	234° 54′ 5″.6	4″.4	1″.5
5–12	α Leonis	5″.0	3″.8	1″.4
Final mean:		234° 54′ 5″.3	4″.1	1″.5

A comparison of the values in tables 1, 2, and 3 leads to the conclusions:

1. That the results of the sun and star observations agree within the margin of accuracy.
2. That solar observations by means of the prism attachment are almost as accurate as star observations.

d. Latitude by circummeridian altitudes of the sun; longitude by altitude of the sun.—Although the main application of solar observations is used for determination of azimuth, some determinations of longitude and latitude were made in order to get a still better estimation of the accuracy of pointing a telescope, fitted with a solar prism attachment, on the sun. That determinations of latitude or longitude are apt indeed to give a much better estimation follows from the fact that the results are not (as in the case of azimuth determinations) influenced by:

1. Errors of leveling the theodolite.
2. Errors of setting up the theodolite over the stake.
3. Errors of pointing on a ground mark.
4. Errors of reading and graduation of the horizontal circle.

From the computed mean errors of a single determination of latitude (m_x) and longitude (m_y), the mean error of a single observation of altitude (m_h) has been derived (assuming the errors of the time clock, the rate, and the reading of it to be negligible) by the formulas:

$$m_h = m_x$$

and

$$m_h = m_y \cos \chi \sin \alpha$$

in which,

χ = latitude of the station
α = azimuth of the sun

The results are shown in table 4:

TABLE 4.—*Latitude by circummeridian altitudes of the sun, and longitude by altitude of the sun*

Date of observation (1947)	Determination of:	Number of observed altitudes	Mean error of a single observed altitude
1–27	latitude	13	3″.4
1–28	"	16	3″.2
			Mean 3″.3
3–1 p.m.	longitude	16	2″.8
3–4 a.m.	"	16	3″.0
3–4 p.m.	"	16	2″.9
			Mean 2″.9

The time required for a single observation was 2.4 minutes (determination of latitude) and 1.3 minutes (determination of longitude). The mean error of a single observed altitude (errors of the time clock, the rate and the reading of it, errors of the graduation and reading of the vertical circle, and errors in the centering of the vernier control bubble included) turns out to be about 3″.

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Giant 200-Inch Telescope

THE giant 200-inch telescope, the world's largest, on Mt. Palomar, Calif., will reach a billion years into the unprobed depths of space. While new close-up views of the moon, Mars, and other planets will be obtained, greatest astronomical interest will be in the photographs of the spectra of the distant stars in remote galaxies. They will tell whether the unsampled remote regions of the universe are like the part we live in.—*Science News Letter*, January 3, 1948.

Guaranteeing a Title

By LOGAN D. FITCH

ASSISTANT VICE-PRESIDENT, CHICAGO TITLE & TRUST CO., CHICAGO, ILLINOIS

EVERY real estate transaction, whether it involves a sale of land or the making of a mortgage thereon, or both, requires an examination of the title to the land in question. The purpose of such an examination of title is to determine who owns the land, and to what liens and encumbrances it is subject at the time of the sale or mortgage. The mere execution of a deed to real estate does not, of course, place the title in the grantee, unless the grantor owns the property when the deed is made. It is necessary, therefore, to examine the title to the lot or tract affected from the time the United States Government parted with its title. As you know, a survey was made of the public land in this State, as well as other states, for the purpose of selling it to individual purchasers. The first item ordinarily appearing in an abstract of title is a patent issued by the United States Land Office to a private owner.

ABSTRACTS OF TITLES

Thus it will be seen that the examination of the title to a tract of land involves a consideration of a long history, consisting of numerous deeds, mortgages, foreclosures, partition suits, and other records filed over a period of one hundred years or more. All these records, filed since the inception of private ownership, must be inspected and abstracted in brief form in order to compile a history of the ownership of a particular tract of land. Such a history is called an abstract of title.

Early in our history it was the custom for the lawyer to go to the public records himself, and to take the information he desired for the purpose of passing upon the title. With the increase in population, and the consequent increase in the volume of the public records, the abstract of title came into use. The abstract of title, prepared by a person or firm in that business, brought to the busy lawyer the information necessary to enable him to make an examination of title. In the latter part of the nineteenth century, with the stiil further increase in population, the further increase in the volume of the public records, the enormous increase in property values, and the attendant increase in the risks involved in the acquisition of title to real estate, the guarantee policy came into use.

The public records from which a title company, or an abstracter, obtains the information from which to compile an abstract, or to examine the title for the purpose of issuing a guarantee policy, are found in the following places:

1. The office of the Recorder of Deeds for the county in which the real estate is situated.

2. The various courts having jurisdiction in the area in which the real estate is situated. Examples of such courts are: city courts, Municipal Court of Chicago, the circuit courts in the various counties throughout the State, and the Federal courts.

Presented at Sixth Annual Illinois Conference on Surveying and Mapping, Chicago, Illinois, May 8, 1948.

3. The offices of the County Clerk, County Treasurer, and County Assessor, and of the Municipality, if any, in which the land is situated.

The records of the Recorder of Deeds contain the deeds of conveyance, mortgages, trust deeds, contracts to purchase, and other recorded instruments. The records in the various courts disclose the foreclosures, partitions, bankruptcies, and other court proceedings which may result in a transfer of the title or the establishment of a lien thereon. From these court records is also taken the information relating to money judgments which constitute a lien on the real estate of the judgment debtor. The general tax records in the offices of the county officials show the disposition made of the taxes on the various parcels of real estate in the county. The lot or tract of land in question may have been sold or forfeited for nonpayment of taxes—the taxes may have been paid, or they may remain unpaid pending court litigation. A record of special assessments, and the disposal of the various installments as they become due, is maintained in the office of the municipality in which the real estate is situated, and in the office of the County Clerk.

Through this labyrinth one must go in order to secure the necessary information with respect to the title when a customer leaves an order for a guarantee policy on a particular lot or tract of land. In order to do this quickly, the title company must have an index of every instrument and court case in the county. At Chicago Title and Trust Company we maintain several indices, namely: A tract index, a judgment index, a tax index, a special assessment index, and a miscellaneous index. Our indices represent a stock of information which, in many cases, will not be used for years to come—until an order is left. In the meantime, we have a large investment in a title plant.

THE TRACT INDEX

Our tract index is a huge bookkeeping system in which each lot or parcel of land in Cook County is carried on a particular page in a certain book as a separate account. Every deed, mortgage, or other instrument filed in the office of the Recorder of Deeds, and every court proceeding affecting land, is posted on the page of our tract index books reserved for the lot or parcel so affected. On the page reserved for a particular lot or parcel will be found the document number of every deed recorded against it and every court suit affecting it. This record is maintained daily. In order to convey an idea of the magnitude of this project—there are, on the average, about 1,200 documents filed in the office of the Recorder of Deeds of Cook County each day. More than 14,000,000 such documents have been filed in Cook County since the great fire in 1871. It requires a force of 65 people to abstract these documents and post them on our tract indices. Our tract indices consist of a set of approximately 2,800 large books.

When an order for a guarantee policy on a lot or tract is left with us we must examine the title to ascertain the ownership thereof and the outstanding liens and encumbrances against it. If we have previously issued a guarantee policy on the land in question, we merely examine the records since the date of our prior policy, using our guarantee file as a starting point. If we have not previously issued a guarantee policy on the property, our examination must begin with the inception of the private title acquired from the U. S. Government. A

list of documents and court cases affecting the lot or parcel upon which a guarantee policy is desired can readily be made by turning to the book and page of our tract indices reserved for that lot or parcel. Such a list is called a "chain" or "chain of title." Using this chain as a guide, an examination is made of each instrument and court suit shown thereon. This examination is made by one of our title examiners from an abstract, or brief statement, of each instrument and court case. These abstracts, or digests, are made for our own purposes by our own clerks who work from the original records.

JUDGMENT AND MISCELLANEOUS INDICES

After determining who has held title during the period to be covered by our examination, we must make a search for judgments against the names of those persons who have owned the property in question at any time during the period covered by the chain of title. In our own office, in our Judgment Index, indexed under the names of the judgment debtors, we have all judgments which are liens on real estate. The Judgment Index, like all our other indices, is maintained daily. We cover more than one hundred court rooms in Cook County from which we take information relating to three hundred or more suits and three hundred or more judgments each day. We must also make a search for any miscellaneous deeds or other matters which affect real setate, but are not shown on the tract indices because no specific property is described. Such matters are indexed in our Miscellaneous Index under the names of the persons whose property is affected. A deed by John Smith conveying "all my property in Cook County," for example, would be indexed against John Smith on the Miscellaneous Index. Also posted on our Miscellaneous Index are many other matters, including corporation charters, insanity proceedings, and estates of minors. We post about 275 items on our Miscellaneous Index each day.

A search of our own Tax and Special Assessment Indices, and of the County's tax records, discloses the status of general taxes and special assessments on the property in question.

DESCRIPTIONS OF PROPERTY

In the examination of titles to real estate one of the most important elements to consider is the description of the land conveyed by deeds in the chain of title. In order to convey title a deed must contain a description which will enable a surveyor to locate the land conveyed. Surveyors are, of course, thoroughly familiar with legal descriptions. However, I shall take the liberty of discussing some of the requirements we make with respect to the description of land in deeds of conveyance. In general we are interested in having descriptions which are sufficient to constitute constructive notice to subsequent purchasers, and which tie in with conveyances of adjoining property. The doctrine relating to constructive notice is very important in the title business. A valid deed filed in the office of the Recorder of Deeds operates as notice to all the world of the grantee's interest in, or ownership of, the land. This is true whether or not other persons actually inspect the record and obtain actual knowledge of the deed. But in order to constitute constructive notice the deed must be valid, and it must contain a sufficient description of the property conveyed. Constructive notice operates in this way: A deed may describe the land conveyed in an imperfect manner, but the description may be sufficient as between the grantor and the grantee. The

grantee may have the deed reformed in court by proving what land was intended. But suppose, that prior to the filing of a suit to reform the description, the grantor, through error or deliberate dishonesty, again sells the same land to someone else, and conveys to the new purchaser by an accurate description. The second grantee may prevail over the first because the description contained in the first deed was insufficient to constitute constructive notice. Thus, had the first deed omitted the number of the section, township, or range in which the land was situated, it would not constitute constructive notice to one who subsequently purchased the same land from the grantor.

The other requirement mentioned, namely tying in with adjoining conveyances, operates in this way. Assuming that *A* owns a tract of land which we shall call Lot 1, which lot is 100 feet wide from north to south, according to the subdivision plat. *A* conveys the north 50 feet of Lot 1 to *B*. Thereafter *A* wishes to convey the balance of Lot 1 to *C*. We usually require that the deed from *A* to *C* describe the property conveyed as "Lot 1, except the north 50 feet thereof." Should the second description read "the south 50 feet of Lot 1" there arises the possibility of an overlap or a gap in the event that the dimension shown on the plat is inaccurate. This rule also applies to conveyances of parts of government sections. Also, division lines must tie in when adjoining properties are conveyed by metes and bounds descriptions.

Surveyors perform an important service in connection with the conveyance of land and the guaranteeing of the title thereto. In the case of a lot and block description the subdivision has been laid out and platted by a surveyor. Insofar as the description is concerned his work has been done in advance of the deeds made by the subdivider. When it is sought to carve out a new description from a part of an existing tract, the services of a surveyor are necessary. Only a surveyor can determine the angles and curves involved in a metes and bounds description which is being used for the first time. Even in cases where a simple lot is divided into two tracts it is possible to encounter difficulty. In one case a city lot, which we shall call Lot 1, was owned by a common owner who conveyed the north part thereof to a railroad company. Chicago Title and Trust Company was asked to guarantee the south portion of the lot. We issued our guarantee policy on "Lot 1, except that part conveyed to railroad by document ————————." (Here identifying the deed to the railroad company.) This was a sufficient description because it tied in with the portion which had been previously conveyed to the railroad company. However, a surveyor now finds that the deed to the railroad company conveyed all of Lot 1, and that our policy, therefore, covers nothing.

THE GUARANTEE POLICY

Having examined the title to the property, we issue a report showing the name of the title holder, and the objections to the title which should be eliminated before our policy issues. The parties ordinarily clear the objections to the title and close their deal. Thereafter we continue our examination to cover the new deed to the purchaser, and issue our guarantee policy in his name.

A guarantee policy shows the amount of the policy, the name of the person or persons whose title is guaranteed, the estate of the person or persons guaranteed—usually an estate in fee simple—and the description of the real estate covered by the policy.

We issue various types of policies to suit particular needs. Among these are the ordinary policy guaranteeing the owner's title, a leasehold policy which guarantees the interest of the owner of a lease, and a mortgage policy issued to the holder of a mortgage on the property. In addition we issue a special policy to contract purchasers, in cases where a deed is not to be issued for a long period of time, guaranteeing the purchaser that the seller has good title.

Among the matters over which we garantee are the so-called hidden risks involved in every title. Among these are: errors in the public records, errors in transcribing or interpreting the public records, the liability of a deed in the chain of title executed by a minor to be set aside at the suit of the minor, a right of dower arising by reason of the misrepresentation of marital status by a grantor in the chain of title, a forged deed in the chain of title, and the possibility of unjustifiable attack upon the title. Many other such risks could be enumerated. The guarantee policy covers these risks, and in the event of an attack upon the title the Company defends at no cost to the party guaranteed. In the event of a loss, such loss is paid by the Company.

There are necessarily matters over which no guarantee can be made. Thus, no guarantee is made against the future exercise of the police power, the bankruptcy power, or the power of eminent domain with respect to the property described in the policy. Nor will a guarantee be made against the consequences of any law, ordinance, or governmental regulation, in force at the time of the policy, or at any time thereafter, limiting or regulating the use of the property. A building and zoning ordinance in a city, or other municipality, limiting the size and kind of buildings, and the use of the property, is an example of such regulation. Nor will a guarantee be made against matters arising by reason of the acts of the party guaranteed; as for example, loss of the title by reason of his own fraud, or by reason of a defect known to him at the date of the policy or when he acquired the title. Such a policy does not guarantee against loss or damage by reason of the refusal of any person to purchase, lease, or lend money on the property, estate, or interest described in the policy. Further, the policy does not guarantee against certain matters which are not of record at the date of the policy. Such matters include mechanics' liens where no notice appears of record, and defects, liens, and encumbrances created subsequent to the date of the policy. Under this category, no guarantee is made in our owner's policy against the rights or claims of parties in possession not shown of record, and questions of survey. Our owner's policy is based upon the record, and we make no inspection of the property described therein. It must be borne in mind that possession of land constitutes notice of the interest of the person in possession. Thus, if one having an unrecorded deed is living on the property, possession of the land constitutes notice of his title under the deed to the same extent that the recording of the deed would constitute notice. However, our mortgage policies issue free of the rights or claims of parties in possession and questions of survey. Since we guarantee over these matters, we must, before issuing a mortgage policy, make an inspection of the property. For this purpose we maintain a staff of eleven inspectors. An inspector visits each parcel of property upon which a mortgage policy is ordered, determines who is in possession and by what right he claims, and ascertains the location of buildings and fences with respect to the lot lines. These inspectors are not surveyors, and if, therefore, a question exists as to en-

croachments, or if a question arises as to the location of the lot lines, we require our customer to furnish a plat of survey made by a surveyor. It must be borne in mind that an encroachment by a neighbor's fence or building may ripen into a limitation title after 20 years. We also make inspections of vacated streets and alleys when we are asked to guarantee the title thereto free and clear of the rights of the public. Our inspector must determine that the street or alley in question has been closed off, is no longer used for public travel, and he must also try to ascertain whether there are any telephone wires or public utility pipes which would constitute an easement across the property. The discovery of public utility easements is not always an easy task, since, in many cases, the easement is serviced by underground pipes and conduits. But we try to locate any such underground pipe or conduit, and if we fail to locate it before our policy issues, it usually turns up later as one of the hidden risks of the title business.

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Texas Surveyors Conference

A NUMBER OF MEMBERS of the American Congress on Surveying and Mapping attended the Texas Surveyors Short Course Conference at Austin, Texas on October 14th and 15th. Representatives of major oil, utility, and engineering companies made up about one-half of the two hundred present at the meeting. The others who came were county surveyors and surveyors in private practice.

The conference, sponsored by Bascom Giles, Commissioner of the General Land Office, and a number of educational institutions, was called primarily for two purposes, namely: To acquaint interested land surveyors with some recent developments in surveying and mapping equipment and procedures; and to discuss the formation of an association of Texas land surveyors.

Among the speakers were Hugh Mitchell, formerly with the U. S. Coast & Geodetic Survey; Leland Barclay of the University of Texas; Robert L. Suggs of Offshore Navigation, Inc., Fagan Dixon, First Assistant Attorney General of Texas; Daniel Kennedy of the U. S. Geological Survey; W. P. Moore, Phillips Petroleum Co.; J. D. Freeman, Land Surveyor; and Ray Wisdom of the General Land Office.

A majority of the surveyors at the conference voted in favor of forming a permanent organization to be known as "Texas Surveyor's Association." Its first function will be to sponsor legislation at the next session of the Texas Legislature which would require the licensing of all surveyors engaged in land boundary work. The next function would attempt to eliminate substandard surveying and strive to improve standards so as to raise the professional status of surveying in Texas.

FORREST DANIELL

Hitching Our Country to the Stars

By REAR ADMIRAL LEO OTIS COLBERT
DIRECTOR, UNITED STATES COAST AND GEODETIC SURVEY

WHERE in the world are we? How deep is the ocean? How high is high water? Finding the answers to these questions has been the job of the Coast and Geodetic Survey during more than a century of surveying and charting our coastal waters, and of establishing geodetic control in the interior of our country. The close relationship that exists between surveys and charts and the stars and planets is perhaps not generally known; yet astronomy is at the very foundation of all surveying operations that deal with extensive areas and that require an accurate orientation on the surface of the earth. Astronomy is the medium by which we hitch our planet to the stars and to the other planets. The engineer, the surveyor, the navigator—who deal with practical astronomy—all owe a debt to the theoretical astronomer, whose determinations of the motions of the heavenly bodies and whose formulation of tables expressing their projected positions on the celestial sphere furnish data for use in establishing position on the surface of the earth—be it of an engineering structure on land, a lighthouse on the coast, or a vessel at sea.

ASTRONOMY AND THE COAST SURVEY

It is an interesting fact that at the time of the inception of the Coast Survey in 1807, there was not a single working observatory in the country for the training of astronomers, and there was not a college in the United States that included a course in geodetic surveying in its curriculum. This is but one example of the magnitude of the task that faced Professor Ferdinand R. Hassler when he accepted the commission from President Jefferson to direct the survey of our coast.

One of Hassler's first hurdles involved astronomy. Being a man of outstanding scientific attainments, Hassler planned a survey along lines of lasting worth and proved value. There were many in those days who saw no need for elaborate base measurements and triangulation systems and who advocated that the surveys of our coast be controlled by astronomic determinations alone. Hassler understood clearly that accurate surveys of extensive areas could only be accomplished by the geodetic process, which is, properly, a combination of the astronomic and the geodetic. Fortunately, Hassler's scientific approach prevailed, and the plan he proposed became the model for our work.

Some of Hassler's contemporary workers and a number of those who followed him were among the foremost astronomers in the country, and their contributions, in both methods and equipment, to the development of practical astronomy are indelibly engraved in the records of Coast Survey achievements.

In 1834 Captain Andrew Talcott, of the Corps of Engineers, discovered the differential method for the determination of astronomic latitude with the zenith telescope. Through its adoption and refinement by the Coast Survey, the Talcott (Horrebow-Talcott) method received great impetus toward world-wide use. The accuracy of the results obtained by this method is superior to that of every other field method and compares favorably with the results obtained with the largest observatory instruments.

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The application of the Horrebow-Talcott method for determining latitude indicated some radical errors in the published star places. The various observatories of the country immediately undertook the necessary additional observations to furnish more accurate star places; so that one of the by-products of the method was an improvement in the star catalogue.

In the early history of the Coast Survey, the determination of astronomic longitude was one of the important problems that required solution. In those early days longitude was determined by observing certain celestial phenomena, such as the eclipses of Jupiter's satellites, which occurred everywhere at the same instant of time. The most practical method, and the one which gave the best results, was the use of highly accurate timepieces known as chronometers. A number of these were used to compare the difference in time between the two places where the observations were being made for difference of longitude. To minimize any error in rate, the chronometers were transported back and forth between the stations.

Within a few months after Morse flashed his first telegraphic message over the wires between Baltimore and Washington, Professor Bache, who succeeded Hassler as head of the Coast Survey, began experiments for an application of the telegraph to longitude determinations. On October 10, 1846, the telegraphic method was put into successful operation, and time signals were exchanged between Washington and Philadelphia.

The determination of longitudes by this method was extended to other parts of the country as rapidly as the electric telegraph came into practical use. Although this established a coordinated network of these accurately located points, it still left the longitude relationship of America with the prime meridian through Greenwich, England, dependent upon chronometric determinations.

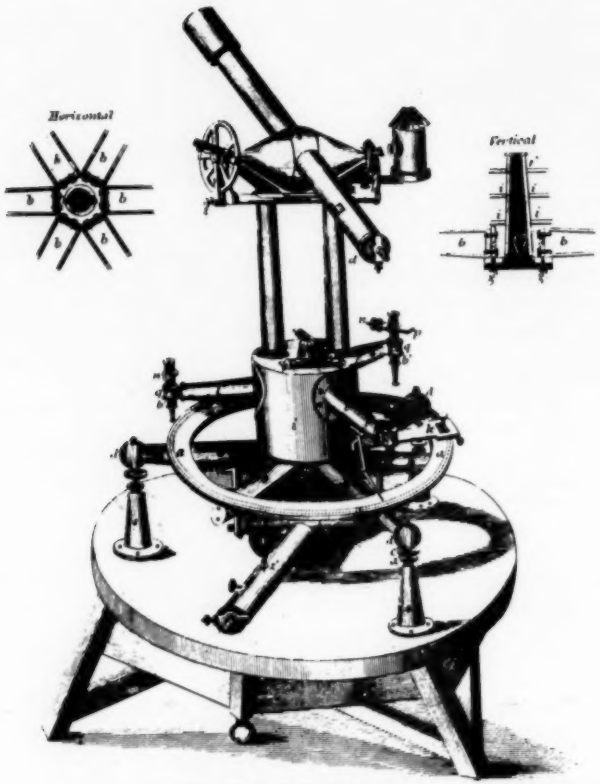
Between 1849 and 1855 the Coast Survey instituted expeditions to exchange chronometers between Cambridge, Mass., and Liverpool, England. In the last year six voyages were made, three in each direction, and fifty chronometers were transported.

Upon the completion of the first successful Atlantic cable in 1866, the Coast Survey, under the direction of Dr. Benjamin Gould, the noted astronomer, organized a project making use of the cable to measure the difference of longitude between Greenwich and the Naval Observatory at Washington. The results proved that the chronometric determination of 1855 was in error by over a second of time, or about 0.25 mile.

The perfection of the methods used in the United States for determining latitude and longitude placed this country well in the forefront of astronomic achievement. It was freely stated at the time that geographical values of the positions of the principal astronomic stations of the Coast Survey were determined with greater accuracy than the values known for any European observatory.

The introduction of the radio method of determining longitude in 1922 did not increase the accuracy of the results, but merely made the determination more convenient and more economical.

In recent years, important contributions to practical astronomy have been made by international cooperation in which the Coast and Geodetic Survey has participated. One of these has been the establishment of a world longitude net for the coordination of longitude work. Another cooperative undertaking has been the establishment of variation of latitude observatories at five places around



24–INCH THEODOLITE

THIS INSTRUMENT USED BY PROFESSOR HASSLER IN THE EARLY TRIANGULATION REQUIRED A SPECIAL HORSE-DRAWN CARRIAGE TO TRANSPORT IT FROM ONE STATION TO ANOTHER. THE STREAMLINED THEODOLITES OF TODAY CAN BE CARRIED BY ONE MAN.

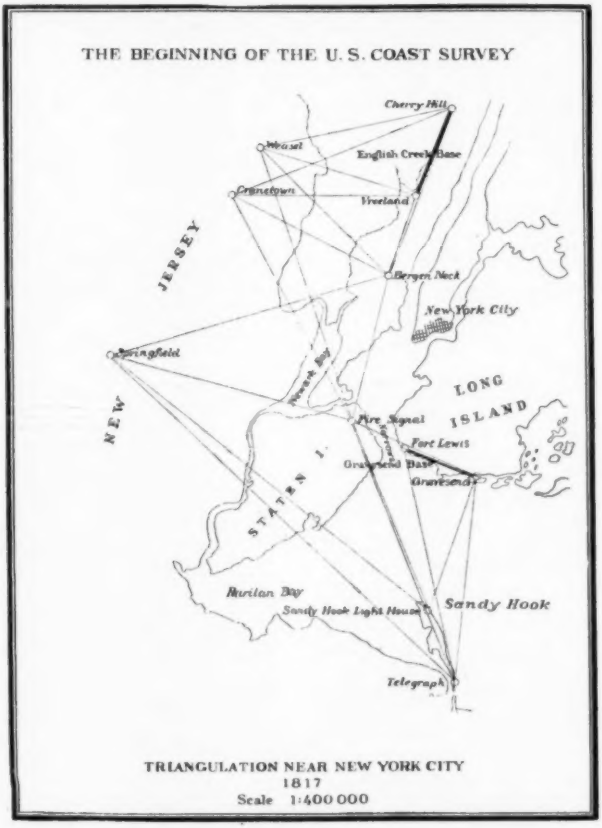
the world on approximately the same parallel of latitude. In this country these observatories are at Gaithersburg, Md., and Ukiah, Calif. The results furnish information for the study of the wanderings of the geographical pole.

TRIANGULATION

When the geodetic surveyor has located a survey point on the surface of the earth from astronomic observations, he has established a starting point for his land operations. The next step is to determine the direction to a second station by an observation on Polaris or other celestial body for azimuth. The third is to make an accurate measurement of the distance between the two stations. These provide the foundation for a method of locating other points on the surface of the earth without making direct measurements. This method is known as triangulation. It is the only feasible method of measuring great distances with a high degree of accuracy, independent of the character of the intervening terrain.

The earliest triangulation work in the United States was executed in 1817 in the vicinity of New York City. It was here that Professor Hassler made his first astronomic observations. In his report Hassler says: "A special station was made upon Weasel Mountain for latitude and azimuth, and a solar eclipse occurring just at the same time gave occasion for an observation of longitude at the same place."

Since this early triangulation, an elaborate network has been extended over the entire country, and tens of thousands of control points have been established. These are permanently monumented with markers for use as starting points in surveys for topographic, geologic, and other forms of mapping, and for every engineering project requiring an accurate knowledge of the horizontal relationship between points on the earth's surface.



FIRST COAST SURVEY

FROM AN ACCURATELY MEASURED BASE LINE (SHOWN BY HEAVY LINES) AND THE MEASURED ANGLES OF A SERIES OF CONNECTED TRIANGLES, THE LENGTHS OF THE OTHER LINES ARE DETERMINED.

The shape and size of the earth must be taken into account in the survey of a country as large as the United States; otherwise, serious errors will be introduced in the results. To determine curvature, astronomy again enters the picture.

From many precise measurements involving astronomic observations and triangulation, the earth has been found to approximate closely the mathematical figure known as the oblate spheroid, with a polar diameter about 27 statute miles less than its equatorial diameter; hence, a spheroid of reference has been adopted for correctly placing the network of triangulation. The adopted reference spheroid deviates from the true figure, and this deviation is greatest in the vicinity of the high mountain ranges and the great ocean deeps. It is because of these deviations that position determination by astronomic observations alone is unsatisfactory. Many cases are on record of such deviations, one of the most pronounced being on the island of Puerto Rico, where a high mountain range runs east and west the length of the island, with the deep waters of the Atlantic to the north and the Caribbean to the south. Astronomic stations had originally been established on the north and south coasts of the island. When these were connected by triangulation, the true distance between them was found to be about 1 mile less than that given by the astronomic determinations.

In any engineering or scientific undertaking involving a large area, it is important that a full coordination and correlation be secured of the surveys, maps, and charts affected. A hydrographic or topographic feature on the earth can have but one latitude and longitude, which must be the same on every map or chart on which it appears. This can only be accomplished through the adoption

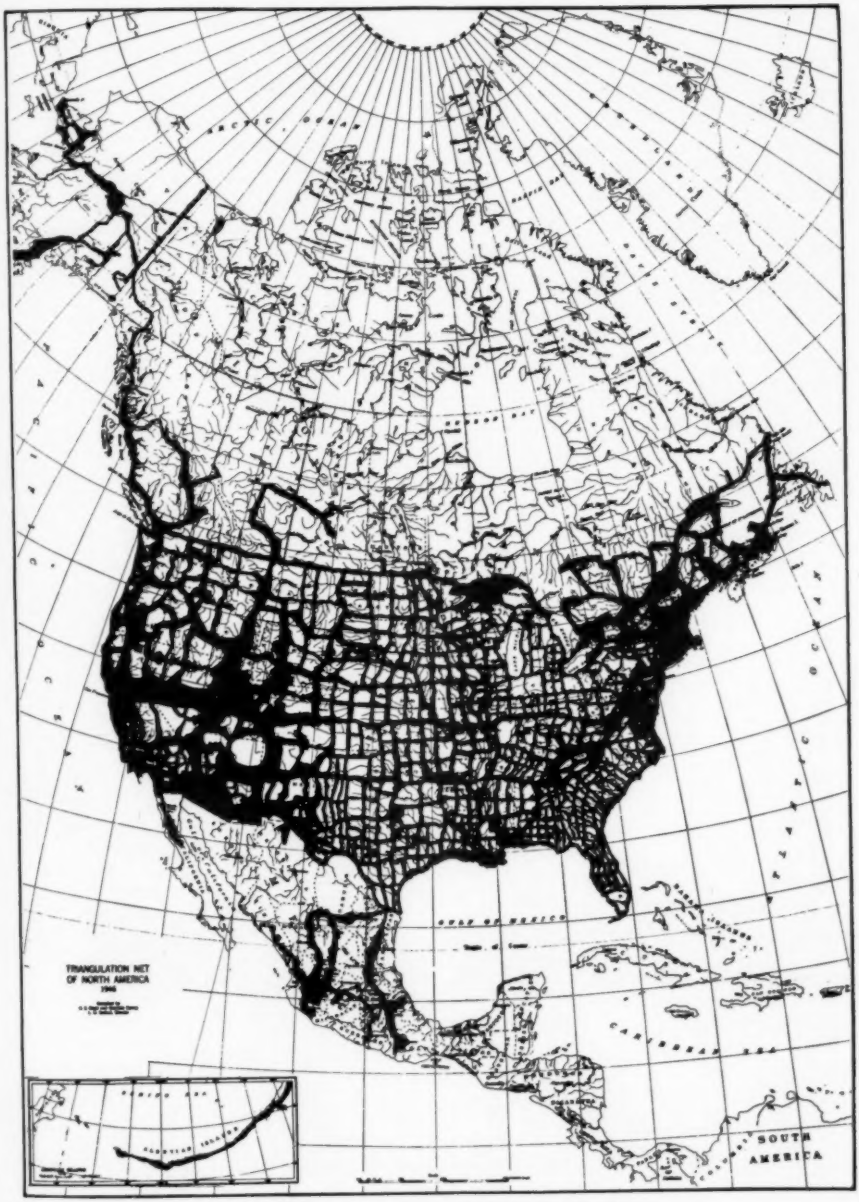
ORIGIN FOR U. S. MAPPING

STATION MEADES RANCH IN CENTRAL KANSAS IS THE ORIGIN OF THE NORTH AMERICAN DATUM OF 1927, TO WHICH ALL FEDERAL MAPPING IS TIED. MANY THOUSANDS OF CONTROL POINTS, PERMANENTLY MARKED WITH BRONZE DISKS SET IN CONCRETE, FURNISH STARTING POINTS FOR LOCAL SURVEYS AND ENGINEERING CONSTRUCTION.

Courtesy Wide World Photos

TOP OF THE MONUMENT

TRIANGULATION PARTY MAKING OBSERVATIONS FROM THE TOP OF THE WASHINGTON MONUMENT, WASHINGTON, D. C. (555 FEET HIGH), IN ORDER TO FIX ITS POSITION IN LATITUDE AND LONGITUDE. NOTE THE COMPACTNESS OF THE MODERN THEODOLITE AS CONTRASTED WITH THE ONE USED BY HASSLER.



TRIANGULATION NET OF NORTH AMERICA

THE DOMINION OF CANADA AND THE REPUBLIC OF MEXICO ARE CONNECTED BY TRIANGULATION TO THE UNITED STATES AND ALASKA TO FORM ONE OF THE LARGEST CONTINUOUS ARCS IN THE WORLD.

of a single horizontal datum for the triangulation points in the country.

In the United States the origin for all Federal mapping is station Meades Ranch in central Kansas. Its latitude and longitude on the reference spheroid were fixed by a mathematical adjustment based on a study of numerous astronomic stations throughout the country that had been connected by a continuous system of triangulation.

Station Meades Ranch was selected because it was near the geographical center of the United States and because it was at the junction of two great arcs of triangulation, one along the thirty-ninth parallel and the other along the ninety-eighth meridian.

Today the continent of North America, from the lower end of Mexico through the United States, Canada, and Alaska to Bering Strait, is coordinated on this single datum. In this network is contained the longest arc of continuous triangulation in the world.

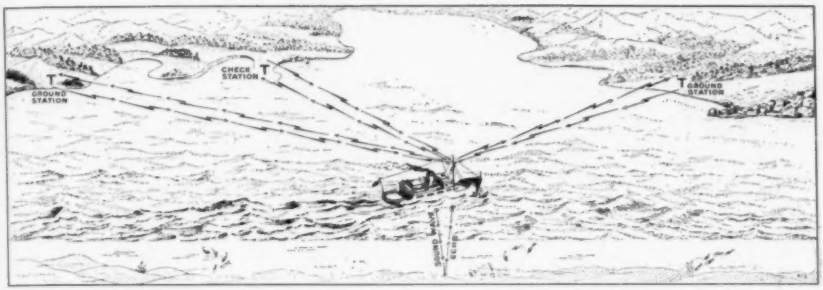
The control points that the geodetic engineer has established along the coasts and in the interior of the country are used by the topographic engineer as the framework for this map. The details he fills in with the plane table or by the more modern method of aerial topography. Photographs taken from the air are reduced to map form by means of specially designed stereoscopic plotting instruments.

MAPPING THE OCEAN FLOOR

Just as without astronomy our land surveys could not be properly positioned on the surface of the earth, so it is with surveys of the water areas. The same

NINE-LENS STEREOCARTOGRAPH

DESIGNED IN THE COAST AND GEODETIC SURVEY FOR STEREOSCOPIC PLOTTING OF TOPOGRAPHIC MAPS FROM NINE-LENS AERIAL PHOTOGRAPHS.



ECHO SOUNDING AND ELECTRONIC POSITION DETERMINATION
WHILE THE SHIP'S FATHOMETER MEASURES THE DEPTHS UNDER THE VESSEL BY SOUND, THE POSITION OF THE VESSEL IS DETERMINED BY ELECTRONIC METHODS.

fundamental problem is involved, although there is a difference in the methods and instruments used. When the navigator leaves the shores of one country and sets out for the ports of another, he has nothing to guide him over the trackless sea except the stars and his chart. Whether he determines his position at sea by observations on terrestrial objects or celestial bodies, or by electronic methods, he must have a chart on which he can properly relate that position to the land area and to the surrounding submarine features. The foundation for the nautical chart must therefore be hydrographic surveys that are tied into the same system of spherical coordinates as is used in establishing control points on land and in delineating the topographic features.

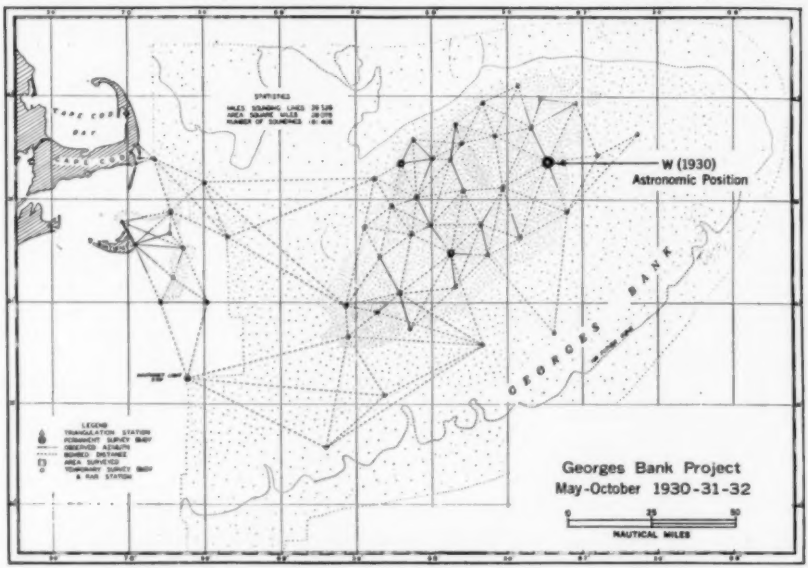
Hydrographic surveying involves a measurement of depth and a determination of position. The revolutionary advances made in this field during the past two decades have had a profound effect on the usefulness of the nautical chart. The measurement of depths by hand lead and wire has given way to measurement by sound—better known as echo sounding. In this method depths are registered automatically on a graduated dial and can be read with equal facility whether measuring a depth of 2 or 2,000 fathoms of water. Graphic recorders are rapid and sensitive enough to detect and record wrecked ships lying on the ocean floor.

Determination of a depth has little value unless the latitude and longitude are known, so that the depth can be shown on the field survey sheet or on the published chart. When in sight of land the position of the survey vessel is determined by means of the well-known three-point fix method from sextant angles taken on board ship to objects on shore previously correlated with the coastal control net. Beyond the limit of visibility of shore objects, underwater sound ranging has been used. By exploding a bomb in the water near the survey vessel, measuring the time of arrival of the sound impulse at two or more previously located hydrophone stations, and employing the knowledge of the velocity of sound in sea water, the distance to the vessel can be determined. Used in conjunction with this method is the taut-wire sun-azimuth traverse. The distances between buoys are measured by means of a taut-wire apparatus, and the azimuths or bearings are determined from observations on the sun.

Occasionally it is desirable to begin a hydrographic survey at the offshore end and work in toward shore. Such was the case with the Georges Bank Survey

begun in 1930. Georges Bank is an important area to both the fishing and the shipping industries. In order to modernize the charts of the Bank as early as possible, it was desirable to begin the survey near the offshore end of the Bank, about 200 miles from Cape Cod, where the westbound shipping lanes cross the continental shelf. The basic position for the project—which comprised an area of about 28,000 square miles—had therefore to be an astronomic one.

A buoy was anchored near the outer edge of the Bank and its position determined by a long series of star observations from the surveying vessel anchored nearby. Eighteen sets of sights were made by three observers on eight days, each set consisting of four or more stars. The position obtained was held fixed for the entire survey, which covered a period of three working seasons. From it, additional control buoys were established by acoustic methods and by sun azi-



BUOY CONTROL SCHEME FOR SURVEY OF GEORGES BANK

A LONG SERIES OF STAR OBSERVATIONS FIXED THE POSITION OF BUOY "W" FROM WHICH THE CONTROL WAS EXPANDED TO A CONNECTION WITH SHORE STATIONS.

muths. When the connection was made with the coastal triangulation, the error in the system was found to be less than 0.25 mile—a result far better than was expected when the survey was begun.

Astronomic sights are used in hydrographic surveying in the same manner as in navigation, except that they are taken with greater precision and care. An observed altitude on a heavenly body determines a circle of position on which the observer is located. Observations made on two or more stars suitably spaced around the horizon define circles of position, the intersection of which determines the position of the observer.

Acoustic methods of surveying have steadily pushed seaward the frontiers of accurate hydrographic surveys and have been used to explore the intricate pat-

terns of our deep coastal slopes. These methods are responsible for the discovery of many new and amazing facts about the continental shelf, the seaward extension of the land mass. The continental shelf is not of uniform width. Off certain portions of the Pacific Coast and Alaska it is quite narrow, whereas along the Atlantic Coast it varies from 10 miles in the vicinity of Palm Beach, Fla., to about 200 miles off Cape Cod, Mass. In general the 600-foot depth line is considered to be the edge of the shelf. From here the submerged land drops abruptly to ocean depths.

On September 28, 1945, a Presidential proclamation extended the jurisdiction and control of the United States over the natural resources of the subsoil and sea bed of the continental shelf. This added approximately 300,000 square statute miles to our jurisdiction in continental United States and about 550,000 square statute miles in Alaska.

U. S. COAST AND GEODETIC SURVEY SHIP *EXPLORER*

ONE OF THE LATEST ADDITIONS TO THE FLEET OF SURVEY VESSELS USED TO EXPLORE THE HIDDEN MYSTERIES OF THE DEEP, THE SHIP CONTAINS THE LATEST IN SURVEYING EQUIPMENT.

Modern hydrographic surveys covering the area of the shelf have modified radically our former belief that the ocean floor is a flat, monotonous plain, devoid of rugged relief. How erroneous this concept was has been amply demonstrated by the many basins and ridges, troughs and peaks, that have been discovered since the advent of the new hydrographic methods. Submarine topography has been found in many areas comparable in extent and magnitude to some of the

major topographic formations that exist on land. The continental shelf—particularly along the northeast Atlantic Coast—is indented by many submarine canyons, penetrating many miles into the shelf. One of the most pronounced of these, and perhaps one of the greatest in the world, is the one that, lying 120 miles southeast of New York Harbor, marks the submerged gorge of the ancient Hudson River. If this canyon could be stripped of its blanket of ocean, we could in some places see across it; the floor of the canyon would lie some 3,600 feet below. The mouth of this canyon has been traced to depths of 6,000 feet below sea level. The Hudson Canyon had been known to geologists for some years, but its true form and size were not known until modern methods of hydrographic surveying were used in 1936.

In the Gulf of Mexico, in the vicinity of the delta of the Mississippi River, a large depression, or submarine trough, has been found that penetrates the otherwise flat and smooth continental shelf for a distance of about 20 miles. To the northeast of this trough is a small dome-shaped hill which, geologists believe, is a salt-dome uplift. It stands about 160 feet above the sea floor and rises to within 200 feet of the water surface. In shape this dome has been found to resemble closely some of the buried salt domes along the coastal plains of Louisiana and Texas where many of our oil reserves are located. Numerous other, similar formations have been found along the edge of the shelf here, 100 and more miles from shore.

Off the coast of California, about 50 miles southwest of San Francisco, a huge submerged mountain has been found, rising 4,000–8,000 feet above the ocean bed and to within 2,500 feet of the sea surface. Other, similar seamounts, some more and some less pronounced, abound along the Pacific Coast and in the Gulf of Alaska.

An unusual and interesting submarine feature along the northern California coast is the Mendocino Escarpment, a clifflike formation, 6,000 feet high on the northern face, that juts into the Pacific for 66 miles, almost at right angles to the general trend of the coast line. This remarkable feature is on the seaward extension of the famous San Andreas Fault, which extends throughout the length of California. The San Francisco earthquake of 1906 was due to earth movement in the vicinity of this fault.

In the Gulf of Alaska, extending from Yakutat Bay and paralleling the Kenai and Alaska peninsulas and the Aleutian Archipelago, there is the remarkable Aleutian Trench. This elongated depression is traceable for a distance of 2,200 statute miles, the last 1,400 of which conform to the arc of a circle of a radius of 760 statute miles. The floor of the Trench stands at its maximum about 25,000 feet below the surface of the sea and about 9,600 feet below the adjacent floor of the Pacific Ocean south of Attu Island. It was along the steep slopes of this Trench that seismograph records fixed the epicenter of the seaquake of April 1, 1946, which gave rise to such pronounced sea waves in the Hawaian Islands and along the California coast.

In the Philippine Islands, just east of Mindanao, is the impressive Mindanao Deep, where the greatest known ocean depth—35,400 feet, or slightly over 6.5 miles—was obtained with an echo sounder. If we could put Mount Everest into this great ocean deep, the world's highest peak would still be covered by a mile of sea water.

Recently, electronic methods have been developed by the Coast and Geodetic Survey for use in hydrographic surveying. These will permit accurate surveys to be extended greater distances offshore than heretofore. Shoran equipment—a form of radar used during the war for precision bombing—has been adapted to, and successfully used for, position determination in the western Aleutians and off the coast of Maine. By this method a survey ship at distances of 50–100 miles offshore can be located with an accuracy comparable to that of a three-point visual fix on shore objects.

Another electronic device is being developed by which control of comparable accuracy with shoran will extend the off-shore limit of accurate hydrographic surveys to as far as 300 miles. This may open up new fields for scientific research in an area that many believe to be a future reservoir of natural resources. Hitherto, one of the great drawbacks to such investigations has been the limitations in the methods of offshore surveying; even with the most nearly perfect geophysical methods there must still be a correlation with certain aspects of hydrographic surveying in order that a reliable topographic picture can be obtained of the area under investigation.

TIDAL PHENOMENA AND PREDICTION

Our country is coupled to the heavenly bodies in still another way. We are all familiar with the rhythmic rise and fall of the sea. This alternate elevation and depression—which at most places occurs daily and which we call the tide—can be expressed graphically in the form of a mathematical curve in which height and time are the two factors.

The Coast and Geodetic Survey is interested in tidal phenomena for two reasons. In its hydrographic work, the height of the tide must be known every instant during which a survey is in progress in order that depths obtained may be corrected and referred to a common datum plane for publication on the nautical chart. Tidal observations are also necessary in connection with the publication of tide tables, which furnish the navigator predicted times and heights of the tide at the important ports of the world.

Another use which is made of tidal observations is in the determination of mean sea level at various points along the coast to serve as a basic datum for the network of leveling extended over the Country.

The connection between the tide and the sun and moon was recognized at a very early period, but it was not until Sir Isaac Newton formulated his theory of the law of gravitation, during the seventeenth century, that a rational explanation of tidal phenomena was advanced. Newton proved that the tides were a necessary consequence of the law of gravitation; hence, the attractive forces of sun and moon on the earth and the waters overlying it are the principle tide-producing forces. The moon being nearer, its tide-producing force is more than twice that of the sun.

If we examine the tide curve for a period of a month, we find that the times of high and low water of one day occur 50 minutes later than those of the preceding day. This period is characteristic of the tide practically everywhere and is irrespective of the range or type of tide found. The moon in its revolution around the earth shows the same retardation of 50 minutes.

The height of the tide during a month is affected by the relative positions of sun, moon, and earth. At times of new and full moon—when sun, moon, and

TIDE PREDICTING MACHINE

THIS ROBOT PREDICTS THE TIMES AND HEIGHTS OF THE TIDE FOR ANY TIME IN THE FUTURE.

earth are in line—the tides have their greatest rise and fall; whereas during first and third quarters, the rise and fall are at a minimum.

Tides differ in the character of the rise and fall. At New York, for example, there is the semidaily type of tide (two tides of approximately equal range); at Pensacola, there is the daily type (one tide a day); and at San Francisco there is the mixed type of tide (two tides with unequal range).

The tide varies in range from place to place. At the Atlantic entrance to the Panama Canal it is less than a foot in 6 hours, whereas at the Pacific entrance, only 30 miles away, it averages 12.5 feet. At Anchorage, Alaska, the rise and fall is approximately 33 feet.

The tides as they occur in nature are the result of the varying responses of the different ocean basins to the tide-producing forces, as modified by local terrestrial features. This theory of the tides that makes them local phenomena, rather than a single world phenomenon, was developed in the latter part of the nineteenth century by R. A. Harris, a tidal mathematician in the Coast and Geo-

detic Survey. In predicting tides for any port, it is necessary first to secure tidal observations for about a year. After that predictions can be made for any future time. Tide prediction is a complicated mathematical process, but the work has been greatly simplified by the use of the Tide Predicting Machine, designed in the Coast Survey. Astronomical equations involving as many as thirty-seven factors are solved mechanically, to produce the tide in nature.

Thus, we see that astronomy is at the foundation of all our survey operations: By means of triangulation we have tied together astronomic observations made throughout the country. This has made possible the determination of the figure of the earth and the best placement of our country on that figure. We have tied into the network of triangulation our mountains, rivers, coast lines, and other land features; and by extending our control network offshore we have tied in our waters, our continental shelves, and the ocean features beyond. In short, we have hitched our country to the stars.

* * *

Symposium on Problems of the Ocean

AMONG THE DOZEN or more symposia held during the Centennial Celebration of the AAAS at Washington, September 13–17, was one on Problems of the Ocean. Oceanography, which includes the study of the physical, chemical, and biological conditions of the ocean and which overlaps allied fields such as meteorology, geology, etc., has made rapid progress in the past decade. These advances range from those that have immediate and important practical application to those that aim primarily at adding to the sum total of human knowledge. There is need, however, for a much better understanding of the phenomena of the oceans. This is emphasized when, in the present state of the world, these great bodies of water must be considered as connecting links rather than separating barriers, and when it is also clear that the rapid rate of increase in human populations requires an expanding dependency on marine resources, i.e., the resources of perhaps the only major area not yet fully exploited.

Early oceanographic expeditions obtained empirical information on currents, temperature, waves, and other phenomena. These followed notable advances in devising physical and chemical theories to explain the distribution of properties found in the ocean, but at the present time these fall far short of actually accounting for existing conditions. Theory and experiment will undoubtedly provide explanations and methods for predicting time changes and for extrapolating knowledge into the depths and other areas thus far essentially unexplored. This goal is still far in the future, however. Because of the complicated nature of the interrelationships that exist in the ocean, it is at present necessary in many cases to turn to empirical correlations to meet immediate demands.

Although fundamentally unchanging, the oceans are never at rest, nor is the distribution of properties ever twice exactly the same. Within limited areas and over short intervals of time, conditions change to a degree that exerts great influences on the organisms living in the sea, on the atmosphere, and on the coasts and sea bottom. Because of these facts the close interrelationship between the various phases of oceanographic research, and their mutual dependence on related fields of endeavor, have long been recognized.—*The Scientific Monthly*, August 1948.

The New Military Grid of the Department of the Army

By DR. JOHN O'KEEFE*

WITH the publication of Technical Manual No. 19, the Army Map Service has completed the work of providing a new military grid for the use of the Department of the Army. This Manual is to be used in conjunction with AMS Technical Manual No. 7, "Tables for the Universal Transverse Mercator Projection, Clarke 1866 Spheroid." The work of providing manuals for other spheroids is in process now; namely, AMS TM's 6, 8, 9, and 11, Tables for the International, Bessel, Clarke 1880, and Everest spheroids, respectively.

To understand the change from the old polyconic military grid to the new transverse Mercator grid, it is necessary to examine the theory behind the use of a military grid. For some of the using arms, the military grid is merely a method of referencing—that is, of naming a particular point on the ground. These arms demand only that (1) the same point should always get the same name and that no other point should receive that name, and (2) that the system be simple. For other arms, however, the military grid offers a rapid means of computing range and distance. By means of the grid, information may be transferred accurately from a map to an artillery plotting board. Upon this board precise ranges and deflections can be measured, in spite of the paper distortions of the map itself, and information from several separate maps can be accurately combined. In addition, the grid offers the possibility of substituting accurate numerical methods for graphical methods, in part at least. Thus, if the coordinates of the target are obtained from the map, and combined numerically with the known coordinates of the gun, it is possible to compute the range and deflection of the target. This method avoids the serious plotting and drafting errors involved in measuring on a map, as well as paper distortion. Whichever method is used, it is almost mandatory for precise fire to determine the orientation by artillery survey, which is most conveniently made in x and y coordinates.

The necessity for using military grids as the basis for fire control had already become evident in the first World War. The *Service Geographique de l'Armee* used the Bonne projection as the basis for the French military grid. This had been developed in Napoleonic times and underlays the famous 1 : 80,000 series covering France. Its unsuitability for this purpose was evident from the beginning for its use introduced errors up to 18 centesimal minutes (about 10 sexagesimal minutes) in the deflections. It was, at first, planned to replace the single Bonne grid for France by a series of narrow strips in which the errors, which increase with distance, could be kept within bounds. In the event of a break-through, this system of narrow strips would have become very disadvantageous since a large number of grid junctions would have to be crossed. The possibility was discussed of using rigorous formulae by means of which correct angles could be obtained after some computation, but it was concluded that "one

* Chief, Research and Analysis Section, Geodetic Division, U. S. Army Map Service.

ought not to dream of imposing such a task upon the artillery officers during the preparation of fire."

There remained only one alternative; namely, to use a conformal grid of sufficient extent to cover the whole front. In a conformal grid, the errors in deflection are made very small. There is little if any improvement of range, but this is regarded as unimportant since the guns themselves are not as accurate in range as in deflection. This grid was the famous French Lambert Nord de Guerre, which was the basis for artillery fire during the remainder of World War I and much of World War II.

The German experience, which is related by Eckert,* was quite similar. The Germans employed the Cassini-Soldner projection; to avoid its errors they employed a multiplicity of grids, one for each Corps area. They were not satisfied, however, and at the end of World War I they replaced all of these Corps grids by a system of transverse Mercator belts, 3° wide.

In the period between the wars, the French and German experiences were widely regarded as decisive and most of the powers which had been employing non-conformal grids replaced them, either wholly or in part. England introduced a transverse Mercator grid in England which partly displaced the old Cassini-Soldner. Holland, Belgium, Poland, and Roumania replaced their Bonne grids with conformal stereographic systems, and the majority of the French colonies replaced Bonne grids by Lambert grids, although in Madagascar, because of the peculiar shape of the island, an oblique conformal grid was introduced. Spain instituted a Lambert grid, Portugal a transverse Mercator, and so with many others.

At the time of American entry into World War II the United States was the only major power which was still utilizing a non-conformal grid for military purposes. The disadvantages of continuing to do so were frequently discussed during the war, both by the Coast and Geodetic Survey and the Corps of Engineers. It was generally agreed that the polyconic grid should be abandoned as soon as possible. This couldn't be done during the war since it would necessitate scrapping all of the maps which had already been produced (e.g., for maneuvers) bearing the polyconic grid. One of the first moves, as soon as victory was in sight, was to start work on a new military grid.

In designing a new American grid, the British experience in World War II was particularly instructive. The British had adopted the general principle of employing, in each area, the national projection and grid. Since most of these grids were conformal they gave little trouble so long as the fighting was wholly on one grid. It was noticed, however, that battles frequently developed directly on grid junctions. This was perhaps to be expected when the grid junctions were made to coincide approximately with national boundaries.

It was decided to modify the principle of utilizing national grids and projections and to set up a military grid system for the world which would be conformal, which would have the minimum number of grid junctions, and which would incorporate the greatest amount of data already worked up.

For this purpose, the transverse Mercator in belts 6° wide, recommended itself strongly. It was conformal, it had far fewer grid junctions than any conceivable world wide system of Lambert or stereographic grids, and it was already

* "Die Kartenwissenschaft," 2 volumes, *Walter de Gruyter and Company*, Berlin, 1921 and 1925.

in use by both the Germans and the Russians. By the application of a scale factor of 0.9996 the accuracy of the grid was improved to 1:2500 in the areas where the greatest artillery battles have been fought in the past. In this way it is contemplated that the gunner and battery surveyor will be able to make use of the grid as a pure system of plane coordinates without any correction whatever.

For the degree of accuracy required in engineering surveys, small corrections to the lengths must be introduced. These are similar to the correction to which the computer is already accustomed for temperature and standardization. In addition, in the case of triangulations, very small corrections (of the order of 1 or 2 seconds) are called for in the angles. Computations remain simpler than those on the polyconic grid and very much simpler than those in latitude and longitude. The computational routine set forth in AMS TM No. 19 is ultimately based on a method originated in South Africa, which proved in the field to be highly practical when regular quadrilaterals with two diagonals could not be observed.

In the application of the transverse Mercator grid to the preparation of maps (Chapter 4 of AMS TM No. 19), advantage has been taken of the fact that paper distortion tends to mask the differences between various map projections. Thus, although the precise mathematical nature of the projection is of the greatest importance for the computation of grid coordinates or of artillery fire, it is not of great importance for the construction of large scale maps. The projection to be used for the construction of a map should be decided by the question of convenience, and in this case the criterion of convenience points clearly to the transverse Mercator projection. A grid can be drafted once and for all as a set of perfect squares of a standard size. Upon this the graticule (i.e., the meridians and parallels) can be plotted in much the same manner as control is normally plotted. This method eliminates the tedious task of constructing the grid from the graticule by "ratioing." At the same time the construction of the graticule itself is simplified to the point where it no longer requires great skill or experience. It is a fortunate coincidence that this approach is particularly well adapted to the coordinatograph and other photogrammetric plotting instruments, as well as making direct use of the control in the form of grid coordinates.

Because of its mathematical properties, the transverse Mercator projection is easily converted to State Plane Coordinates of the United States, or vice versa. The transformation is actually easier from one grid to another than from either grid to geographical positions or the reverse. Thus, it is hoped that by the use of this grid, work done throughout the United States in terms of the local coordinate systems can be gathered up in an emergency and assimilated to the national grid. Formulas for this purpose are collected in Chapter V.

In the same chapter, the formulas are set forth for converting from geographical positions to UTM coordinates. These formulas are to be used in conjunction with AMS TM's 6, 7, 8, 9, and 11, which contain the fundamental tables for the transverse Mercator projection.

* * *

THE NINTH ANNUAL MEETING, JUNE 8–10, 1949, WASH., D. C.

Just Where Are Our Instrument Makers?

By THOMAS E. RILEY

REGISTERED OREGON SURVEYOR

DURING the late conflict many American surveyors had the chance to see and use foreign surveying instruments. Some of us were lucky enough to have the use of the Wild optical theodolites—purchased by the Army just prior to the war. After using these Swiss theodolites and testing similar enemy equipment, we began to wonder if something was wrong with our own much-vaunted instrument makers.

Even so, we did not comprehend that much improvement could be made in levels. Levels are comparatively simple instruments. And we were accustomed to seeing nearly all our levels—no matter the brand—made in either the standard dumpy or wye design. Today, after trying the new Wild levels that are now being imported into the United States, we are finding it quite possible that the American dumpy and wye should be relegated to a museum alongside Galileo's first telescope.

During the war we learned that in sturdiness, ease of operation, rapid progress, and in number of men required, the Army's Wild theodolites completely outclassed any other surveying instrument. As for accuracy, these optical theodolites were, due to their small size, slightly less accurate *in laboratory tests* than our big, first-order Parkhurst theodolites. But, due to their ease of operation, the Wilds gave, if anything, more accurate and more consistent angular closures in the field. With the levels it is a similar story. Greater efficiency in all respects—and consistent, accurate results.

It did not seem unusual to hope that this last war would bring us the world's advancements in surveying. The first world war brought us France's Lambert conformal projection and Germany's know-how of manufacturing optical glass. But today we simply *know* of the Swiss surveying instruments—we do not make them. Instead we find that an attempt to manufacture such instruments has already failed. Even before the supply of European instruments was cut off by our entering the late war, the Army Engineer Board realized the need and was trying desperately to design both a new theodolite and a new level. As do private surveyors, the Corps of Engineers had a critical need of instruments that would give accuracy with smaller, less-skilled crews. Designs of advanced instruments were produced by the Engineer Board during the war, and they turned out to be copies of the Wild T2 theodolite and the Wild N2 level in every basic detail. Pilot models of the new instruments were made by two of our best manufacturers—and in the failure to produce them in quantity we find one excuse for our not manufacturing the best surveying instruments. It takes craftsmen to construct the optical elements of these modern surveying instruments. It seems that American industry, geared to assembly lines, can only do skilled handwork at a slow rate and at a terrific cost. We would have to pay something near the astronomical figure of $6,000 for our own optical theodolite; whereas the comparable European instrument costs but $1,100, including the import duty.

SHORTCOMINGS OF AMERICAN LEVELS

But the scarcity and high cost of skilled handwork does not completely justify our lack of advancement in our levels. Even if manufacturers cannot economically build the optical instruments, they should at least be able to emulate some of the simpler advancements of the European levels. Is there any reason for our engineers' levels being heavy, bulky instruments with 18- to 20-inch telescopes? It is a very old belief that a long telescope is necessary to give any accuracy. Incongruously, our most accurate level (the USC&GS precise) is a little shorter than most of our others. Using a direct comparison, we find our present wyes and dumpys with 18-inch telescopes; whereas the Wild NI (standard European construction level) is only 6.3 inches in length (fig. 1), and the Wild NII (accurate tilting level for both construction and semi-precise surveys) is only 8 inches long (fig. 2). In weight, we find that the Wild NI is 3.3 pounds —our latest wye 12 pounds. A man can carry the compact NI in a coat pocket. Until its capabilities are realized, the European level seems too easy to operate, like a toy to an American surveyor used to ponderous, bulky designs.

Besides the compactness and ease of operation there are many other advantages in the European levels. Critically-sharp definition and wide field of view are present. With short focal length and well-designed internal focussing the telescopes of the European instruments will allow the closeup rod readings so necessary in construction layout. To be specific, the Wild NII will focus sharply on a level rod as close as 6 feet, the NI up to 5.25 feet.

The inherent defects that could easily be eliminated from our instruments are the troublesome crosshairs. There have been no crosshairs, as we know them, on European levels for a quarter of a century. Accurately-etched lines on optical glass disks are used instead of the coarse platinum wire or the spider web with its resulting sag in wet weather. We recently learned how to make these glass disks when making the Engineer Board's optical theodolite and level —is it too much to ask for mass-production of this one optical improvement? The lines can be etched extremely fine and sharp in definition on the optical glass. Obviously there is no possibility of sag nor danger of breakage from cleaning or slight jars. Also, stadia lines do not have to be threads that stretch completely across the field of view. They can be short lines cut on the optical glass reticules or be lines otherwise marked so that no mistake is ever made of reading a stadia line for the horizontal centerline.

By simply increasing the size of the objective lens we could have the superior brilliance (light-gathering properties) of the European levels. Our present wye and dumpy levels have telescopes with as high a magnification as any instrument, but they do not have the brilliance necessary in dull weather. High magnification is essential to read a level rod at long distances, but for every increase in magnification there is a corresponding decrease in brilliance unless a larger objective lens is used. Even if it means additional cost, our levels should also have the large objective lens and thus be capable of clear observations inside buildings and in dull weather.

Another improvement—a mass-production item as simple as a Ford fender—would be the hermetically-sealed instrument cases. The European makers furnish these rubber-sealed metal cases with all their instruments, giving the best of protection from rough treatment and a complete exclusion of dust when in transit or storage—the time most instruments are fouled. These cases proved

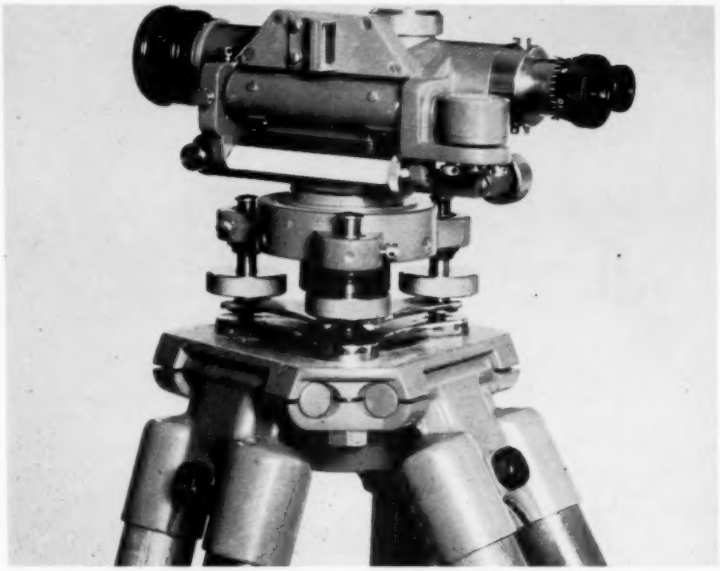


FIGURE 1.—The Wild NI construction level.

FIGURE 2.—The Wild NII general purpose level. This compares with our semi-precise levels.

their worth to the U. S. Army. In New Guinea and the Philippines they kept the optical instruments from fouling under conditions that quickly ruined all U. S. makes. In Alaska one survey party of the 29th Topographic Engineer Battalion reported swamping a boat in the rapids of a glacial stream. They saw their Wild theodolite bobbing along in its case, recovered it, and went on to turn second-order triangulation closures with that instrument as if nothing had happened.

These improvements that have been mentioned would not entail a complete and extensive change-over to the European type. It should not be a tremendous job for our instrument makers to incorporate some of them. Unfortunately, such improvements would still leave us without the coincidence method of viewing the bubble (fig. 3) which results in the greatest advantage of all, the dispensing with moving around the level while observing. Nearly all European levels use the Wild prism-system of coincidence for viewing the bubble (optical prisms that match split images of the two ends of the bubble). With nearly all of our levels the surveyor must be constantly moving around the instrument to check his bubble (fig. 4). One or two of our semi-precise levels now have an adaptation of the coincidence system, but with hinged mirrors replacing the firmly-mounted prisms. These mirrors nullify the advantages of

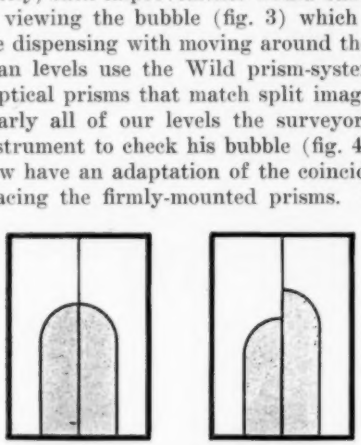


FIGURE 3.—Bubble centered by coinciding edges.

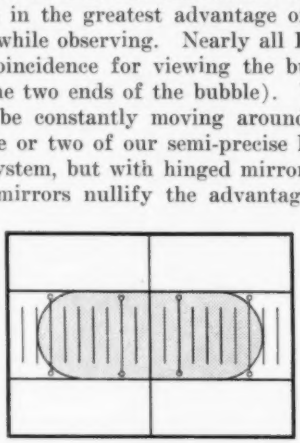


FIGURE 4.—Bubble centered by graduations on vial.

the system by being easily damaged, by giving a dim, hard-to-read image, and by giving extreme errors in parallax unless constantly adjusted and tested. Our USC&GS precise level uses a prism system (the Berthelemy), somewhat similar to the coincidence method but awkward to read in that it simply reflects the graduations of the bubble vial instead of coinciding the sharply-defined split edges of the bubble itself. Another fault of both American adaptations is that the bubble vial is left fully exposed to the sun. Even in the simplest of construction surveys, the enclosed vials of the European type give better accuracy and easier operation on hot days by diminishing the annoying creep of the bubble.

There are other advancements in the European levels that we do not have. The ball-bearing, cylindrical vertical axes are less sensitive to changes in temperature and to wear. Working parts are enclosed in sturdy, one-piece castings, so well enclosed that the instruments will operate in downpours of rain. With the precise levels a surveyor can use a micrometer wedge for extremely accurate readings. One of the precise levels has an instrument in adjusting for collimation in the field—the surveyor simply turns a wedge-shaped plate of

optical glass in the telescope rather than guessing (we call it estimating) with the locking nuts of the bubble vial. It has been stated that our designers are right now considering a change to at least some of the minor improvements of the European instruments. The amazing thing is that for a quarter of a century the improvements have been known and used throughout the rest of the world. Dr. Heinrich Wild of Switzerland invented the optical surveying instruments. Other European makers, Zeiss of Germany included, have copied the Wild principles. Even England, from where our surveying methods originated, now builds the Tavistock, an optical theodolite. But American designs have not advanced, not even in the most minor respect.

It may be that our surveyors are as much at fault as the instrument makers. Manufacturers repeatedly state that the bulk of American engineers still prefer the dumpy and wye. But the bulk of American engineers have never, until recently, had the opportunity to test and use the European instruments. Now, with the optical instruments becoming better known and being imported, our manufacturers seem concerned. We can still do an accurate job of leveling with a dumpy or wye, but we can now buy a Wild level at less cost and with it can run the same surveys in less man-hours. This efficiency is why the Inter-American Geodetic Survey is using the Wild NIII for all first-order work in the Canal Zone, and why so many contractors and government agencies are demanding the European instruments for general surveying.

We had capable survey instrument designers five decades ago. The levels they produced were excellent for that time, but those designers and manufacturers can be credited with even our most modern level, the USC&GS precise. Our government agencies standardized that instrument for first-order leveling. In a more haphazard way the dumpy and wye levels were also standardized about that same time. Perhaps this is another reason for our retrogression in instrument design. Standardization of a mechanism is a valuable asset in terms of years, but it is definitely the opposite in terms of decades. Even Henry Ford had to admit that. It is not reasonable nor believable to proceed as if we designed our surveying instruments beyond improvement fifty years ago.

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Earth's Early Magnetism to be Tested with Clays

What amount to tiny magnets in the clay particles laid down in ancient glacier lakes or on the ocean bottom can be used to determine the strength and direction of the magnetic field when the clay beds were formed.

Glacial clays from New England and sediments from the bottom of the Atlantic and the Pacific formed a million years ago have been collected by the scientists. Pieces of the material are spun near a coil and extremely sensitive amplifiers are used to pick up the very small voltages generated. From these there can be figured the strength of the earth's magnetic field in which they were deposited.

A million years ago the earth's magnetism was just about what it is now. Seeking clays of earlier geological ages, the scientists will find records of the earth's magnetism still earlier.—*Science News Letter,* May 8, 1948.

Bowditch Method of Adjusting Transit Traverses—A Justification

By B. GOUSSINSKY
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THE TYPE of traverse considered here is the so-called "framed traverse," or traverse with complete position and bearing control. This means that in the general form the traverse has two terminal points fixed by coordinates, and that its orientation is determined by two limiting lines, the azimuths of which are known. The closed circuit traverse is a particular case, beginning and ending on the same point for which the coordinates are known.

In a traverse with n intermediate points, the coordinates of which are to be computed, the measured lengths of at least n sides must be given, as well as n angles providing the bearings for the n sides. Usually, in a fully observed traverse, $n+2$ angles (on all the $n+2$ stations) are observed, and $n+1$ sides (between the $n+2$ stations) are measured. There are thus 3 additional observations. This number is relatively small when compared with the number of unknowns to be determined (corrections to observed angles and to measured lengths of the traverse sides). The method of conditioned observations is, therefore, the most suitable for carrying out the adjustment. The 3 additional observations make possible the establishment of 3 equations of condition, of which one is in angles, and the other two in coordinates.

The discrepancies in the condition equations are the results of errors in the observations; but, whereas those in the coordinate equations are functions of errors in both angular and linear measurements, the discrepancy in the angular condition equation is a function of errors in angle observations only. A set of the 3 condition equations can be considered, therefore, as composed of two different types, the condition equation in angles (called also the azimuth condition equation) and the condition equations in coordinates.

This points to the possibility of splitting the work into two separate adjustments. Several means can be used for the purpose, and some of these will be described below. In all of them the angular condition equation is adjusted first, independently. This is usually achieved by distributing the error of angular closure evenly among all the observed angles, on the assumption that all of the angular observations were made with approximately the same accuracy. Consequently, a single set of angles and bearings is obtained for the formation of the coordinate equations. This preliminary adjustment of the angular condition equation is in full agreement with the theory of least squares if values obtained from it are substituted in all the condition equations and the complete set adjusted.

In Prof. Eggert's rigid method (1) the preliminary coordinates of all the points are computed at the time of establishing the condition equations in coordinates. The system is then transformed by taking its center of gravity as the origin of coordinates. In this way the set of 3 normal equations is reduced to a set of two only, the normal equation corresponding to the angular condition equation having been eliminated. This actually amounts to dealing with the coordinate condition

equations only. In England, Mr. Jolly successfully applied this device (2) in his commentary on traverse adjustment by least squares.

When the problem is the adjustment of ordinary traverses for which the rigorous treatment by least squares is not indispensable, the coordinate equations can be treated by themselves, either by holding the preliminarily adjusted bearings fixed and considering only the corrections to the lengths as the unknowns of the adjustment, or by considering the corrections to the increments in latitudes and departures as the unknowns. In the latter case, both the lengths of the sides and their bearings undergo alterations. The idea underlying this method is that the effect of errors in angular observations is negligible when compared with that of errors in linear measurements (3).

In the following discussion a method of adjusting transit-and-tape traverses will be described, which, though not considered as such before, can be shown to be practically as acceptable as the rigid adjustment by least squares.

When the condition equations in coordinates are being established, they are expressed first in terms of corrections to lengths and bearings, the latter having been obtained from the preliminary adjustment of the angular condition equation. The actual unknowns, however, are not the bearings, but the angles included between the traverse sides, they being the originally observed quantities. Thus, finally, the coordinate condition equations must be transformed so as to be expressed in terms of corrections to angles and not in terms of corrections to bearings.

This operation obviously results in a more complicated form of equation, as well as in a more complicated procedure of adjustment, and the question arises whether it would not be permissible to use the bearing corrections for the unknowns, instead of transforming the equations into terms of angular corrections. However, the advantages of such a substitution are manifold, as will be shown below.

The transference of corrections from originally observed quantities to values derived from them is a regular occurrence in observation adjustment technique, and the following typical examples may be cited:

1. In leveling, the observations directly affected by errors are the readings on the staff; yet, the values actually adjusted are not these staff readings, but the differences between them.

2. In triangulation networks observed by the method of directions, and before the condition equations are established, the rays of each station undergo a special "station adjustment." These preliminary adjusted directions are then used in the acid test by triangular closures and in the final formation of the geometric condition equations, as if they were the originally observed values.

On the face of it, there is no lack of arguments for such a substitution. The coordinate equations become more symmetrical, there being now as many corrections to bearings as there are to lengths (each of the sides being corrected for distance and bearing). It is also quite natural to consider in the first place the bearing corrections as the unknowns, the discrepancies in the coordinate equations being immediate functions of these corrections and not of corrections to angles.

The main value of this substitution, however, lies in a quite different sphere; viz., in that the angular equation is thereby entirely eliminated. This is obvious, since whatever the corrections to the bearings resulting from the adjustment, the angular condition will always remain satisfied. This is only a particular case within the general rule, according to which direction referring to one and the same

reference object cannot give rise to a condition equation in angles. It explains, for instance, the vanishing of the horizon condition equation in the direction method of triangulation adjustment. In traverses, all of the directions are referred to the same meridian—and are called bearings.

We have thus split the work of adjustment into two separate parts. First, the angle equation is adjusted by itself. Second, with bearings obtained from the first adjustment, we have to deal only with the two condition equations in coordinates, the adjustment of which does not upset the condition, already satisfied, of the closure in azimuth. On the other hand, it can be easily recognized that we have now come across the conditions as laid down in the Bowditch problem—given the bearings and sides of a traverse line, to find their most probable values and reduce the errors of closure in latitudes and departures to zero. The errors are assumed to be of accidental nature only, in both angular and linear measurements (4).

The results of Bowditch's solution show that the so-called Rule of Parallel Partition is to be adopted. According to this, the errors of closure in latitudes and departures are distributed among the increments in proportion to the lengths of the respective traverse sides. It is generally considered that the Bowditch method is applicable only to traverses in which bearings have been directly observed and for this reason it is also called "The Compass Method." As we are going to see, there is no reason why the rule should not be used in adjustment of transit traverses too; i.e., traverses in which the angles included between the sides have been observed and the bearings of sides derived from them.

The main difference between directly observed bearings and those derived from angles, when their use in the adjustment of traverses is considered, is that the former are independent, whereas the latter are obtained from each other by consecutive addition or subtraction of included angles. But this is not the case with angles already satisfying, after the preliminary adjustment, the condition of closure in azimuths. Here we have a single, crystallized set of angles and the bearing of a side remains the same regardless of whether it is computed from the beginning or end of the traverse. The question of independence of bearings from each other must not be confused with that of their relative accuracy. Though the accuracy of the adjusted bearings of the different sides varies, decreasing towards the middle of the traverse, their relative independence is in no way affected.

Two supplementary remarks may be added to justify, from the practical point of view, the application of the compass method in adjusting transit traverses:

1. The probable average accuracy of angles and bearings is increased after the preliminary angular adjustment.

2. Bearings derived from previously established lines of fixed azimuth and angles observed by transit are, as a rule, more accurate than compass bearings or any other directly observed bearings.

Bowditch's rule is based upon the following assumptions of the relative accuracy of measurements: For sides, the weights of the linear measurements are in inverse proportion to the lengths of the sides, and for bearings the weights are in direct proportion to these lengths. There is no doubt that Bowditch's method of allotting weights is the result of an ad hoc estimation. Nevertheless, it is as well founded as any other theoretical estimation. In linear measurements, accidental errors are ordinarily supposed to be proportional to the square root of the lengths of the lines measured. In angular measurements the estimation of

accuracy is more difficult. However, taking the main source of errors to be in eccentricity in setting up the instrument over occupied stations and in signal observations (the latter including the errors in bisection), the assumption is, at any rate, in the right direction; i.e., the errors decrease as the lengths of the rays increase and vice versa. This in no way contradicts the assumption of equal weights in the preliminary angular adjustment, for the simple reason that the accuracy of an angle, as the difference of two sights, is no longer an explicit function of the lengths of respective rays, as the case would be with individual sights.

I have tried in this discussion to justify theoretically the procedure, de facto almost universally adopted, of using the Bowditch method in adjustment of transit traverses. Through the course of reasoning followed, it is concluded that computers may, with a clear conscience, continue to adjust traverses in the familiar and easy Bowditch way.

The paper is also intended to serve as a tribute to the American mathematician who provided surveyors all over the world with a most effective and simple method of traverse adjustment.

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Surveys of Palestine Report

AN ILLUSTRATED REPORT of the Department of Surveys of Palestine for the years 1940–1948 describes the acceleration of survey for settlement of title to land and the expansion of the map production sections of the Department during the 8 years under review. On an average, 20 survey parties were in the field during this period.

Attention was given to village development surveys in connection with the postwar reconstruction program in Palestine. Coordinated survey procedure promoted by well defined stages of survey work eliminated unnecessary work which resulted in more efficient prosecution of land settlement operations.

The progress of topographical and special surveys in Palestine is presented by tables and index maps. The status of topographical map coverage, triangulation, leveling, town and village plans, and land settlement, is presented graphically in color. Survey of Palestine publications are listed.

Use of Plane Coordinates in Highway Planning

By B. EVERETT BEAVIN
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THE HIGH COST of modern highways and the critical nature of the problem of collecting, carrying, and distributing motor traffic indicates that more study should go into the planning stage than ever before has been considered necessary.

If the progress of the study is not to be delayed while all practicable routes are explored, surveyed in preliminary fashion, and a final general route selected, some other method must be adopted. Obviously, these older methods are too costly to permit the study of *numerous* alternative routes; and there is the certainty of a concerted rise in property values the instant road survey parties start work in any neighborhood.

The problem may be met largely by utilizing to the limit recent advances in aerial photographic mapping and soil identification methods and by taking advantage of all map and survey data available through federal, state, and local agencies, including public utilities. To serve their purpose best, these data should be made comparable by referring them to a standard system of horizontal and vertical control. What, then, is this system and how does it operate?

With few exceptions, mean sea level is taken as the datum to which public surveys are referred for vertical control.

Horizontally, however, there has been very little uniformity in referencing highway surveys; and it is about time that this situation is corrected.

The State Coordinate Systems offer an easily used horizontal reference framework of plane rectangular coordinates, to which all surveys may be referenced and to which may be transposed local coordinates of previous surveys by other organizations, thus permitting easy use of valuable existing maps.

Let it be said here that a coordinate system has many more uses than just for checking and balancing surveys. To derive all of the potential benefits, the earliest thinking about a project should be in terms of coordinates; and the Coordinate System should be used for correlating maps and surveys, writing reports, compiling traffic data, exchanging information with other agencies, acquiring property, and generally simplifying control of operations.

Coincidentally with the advance planning of the highway, there should be prepared an outline plan for the surveys and mapping. If we are to start our thinking on a co-ordinated basis, then, we must have co-ordinated maps at the beginning.

Recent Government maps have the state grid ticked off along the sides; in the case of older maps, tables giving State Coordinates of latitude and longitude intersections at 15-minute intervals are available or may be computed readily. Grid lines may be inked on the maps at 5,000- to 10,000-foot intervals and linen reproductions made at a blown-up scale of 1″ = 1,000′ or larger if desired. White

Presented at meeting of Planning Division of American Road Builders' Association in Washington, D. C., January 28, 1948.

prints from these maps are excellent and cheap media for advance planning of every description.

Before printing, in order to make the basic data available to all concerned, all existing horizontal and vertical control should be drawn on the map, showing coordinates and elevations and the maps of other agencies outlined thereon or referred to by notes. At present, it may be necessary to convert some of these surveys from local coordinates to State Coordinates. At some happy day, far removed, no doubt, the great mass of existing data will already be referred to the State System and such conversion will not be necessary.

At this stage of the study, existing aerial photography should be utilized to the utmost. The wealth of detail shown will repay the effort necessary to obtain the photographs from the proper authorities.

Using the 1″ = 1,000′ co-ordinated maps, aerial photographs, and all other available data, a number of routes may be studied with numerous variations and combinations. Discreet reconnaissance along public roads in the area will be of service in selecting the most desirable route. Studies during this period should include approximate designs and estimates of drainage structures, interchanges, and consideration of soil types.

After the approximate route is determined, a decision must be made whether to proceed with ground surveys on the basis of the data already available, or to have up-to-date aerial maps made. I believe that the additional expense of complete new strip maps is justified in the case of modern dual highways.

Assuming that the decision is made to secure complete new maps, specifications may be drawn and a contract awarded for the work. 1″ = 200′ is a convenient scale, with 5-foot contour intervals. Except for the most densely wooded areas, it is possible to secure an accuracy of one-half a contour interval, or 2½ feet. Many aerial mapping companies will perform the necessary ground surveys to control the accuracy of the map. We prefer to furnish the control, using the triangulation, traverse, three-point stations, or any combination of these, establishing stations for future final surveys at the same time the picture points are coordinated. The mapping company plots these picture points by coordinates and thus constructs a very accurate backbone for the strip map. Road junctions, fence intersections, and other well defined objects make excellent picture points for control. These control surveys may be extended into the area from nearby stations in such a manner that the location of the proposed road will not be disclosed.

With accurately co-ordinated strip maps, it is possible to make very close studies and estimates of drainage features, interchanges, structures, relocation of existing roads, and other costly features of design. Using data procured from other agencies, large sewers, drains, tunnels, or other structures may be plotted and the alignment modified as found necessary. Where highways cross rivers, piers, railroad yards, high value districts, and densely populated areas, the ability to study many locations and variations without costly and time-consuming surveys, presents the opportunity for substantial savings in time and money.

The writer does not feel, however, that present-day aerial topographic maps are accurate enough to serve as a basis for final plans and quantities for payment. After the final location is adopted, the work of preparing final surveys and plans is begun, working either from the co-ordinated traverse or the centerline, whichever is easier to establish.

Most engineers cross-section the work directly in the field, but the writer prefers, particularly in rugged country or at interchanges, to prepare large-scale, co-ordinated planetable maps to a 1-foot contour interval. From such maps as many cross sections may be taken as are required by the complexity of the structure or variations in topography. Drainage design is improved where such a map is available. The Coordinate System enables the accurate plotting of curved roads on numerous adjoining sheets, of a size which is easily handled, without the accumulation of error.

At the same time that roadway planning is evolving, property surveys may be proceeding, tied in to the Coordinate System. The land surveyor's work then may be transferred to the highway drawings with ease, or vice versa.

Contact prints of the aerial photos, in the hands of a competent soils man, trained also in airphoto study, offer a valuable contribution toward selecting the best location.

During the construction of the highway, coordinate stations off the centerline may be used for re-establishing the highway lines as often as they become destroyed; and, after construction is finished, they perpetuate the location of property lines, making unnecessary the wholesale monumenting of the corners. Many of these property markers are destroyed after a short time, so it seems advisable to perpetuate the control survey and re-establish property corners and other points on the roadway only when circumstances require.

As an illustration of how co-ordinated surveys expedite later surveys, in 1944 we prepared plans for the Washington-Baltimore Freeway, between Jessups and a point near the Patapsco River. These plans have been held in abeyance since that time. All of these surveys were co-ordinated on the State System and the values shown on the drawings. Only the traverse was monumented. No matter how long the work may be delayed, the lines may be re-established exactly, even if all original marks are destroyed.

In 1946, co-ordinated plans were prepared for a new airport and access road which will connect to the Baltimore-Washington Freeway when constructed. All of the preliminary designs were, and many of the final solutions may be, accomplished without doing any field work, simply because the Coordinate System is a tie in itself. The savings here were considerable; and, no doubt, other major highways and public projects eventually will have to fit into the Freeway scheme and the existing coordinates will permit other savings to be realized. The State Roads Commission now is studying several modifications of the Baltimore end of the Freeway; and we are able to exchange information, by telephone, by mentioning only a few coordinates, that would require sketches, prints, and field work if all the work were not co-ordinated on a single statewide system.

Another very interesting application of coordinate control to a highway survey occurred last year. One afternoon, we were instructed to begin surveys for the 4½-mile long Chesapeake Bay Bridge and its approaches. About 5 minutes' time sufficed to pick from our files the coordinates of all nearby triangulation stations, domes, towers, lighthouses, bends in channels, and other features. The next morning, we were on the bay, equipped with sextants, and were able to ascertain our position at all times. Reconnaissance was greatly facilitated. In a few days, we had prepared graphical solution charts for the three-point problem and were able to plot our position almost instantaneously, without the use of three-arm protractors, drawing boards, or other devices. Only a pencil was

needed. Obtaining a boat equipped with a sonic depth finder, and aided by these charts, we were able to make soundings in water up to 90 feet deep (and this in midwinter) in a few days that would have required many weeks by ordinary methods. Accuracies obtained were found to be satisfactory. This method also eliminates the necessity for survey parties standing by for long periods at shore stations to cut in the soundings. By this combination of modern methods, which would not have been possible without the co-ordinated surveys, many thousands of dollars were saved.

The uses of coordinates touched upon in this paper are only an indication of the manifold benefits possible. To be in a position to realize these benefits, the engineer must think in terms of coordinates through the various stages of conception of the project, preliminary or advance planning, aerial surveys, and final determination of the alignment, final surveys, property acquisition, construction, and maintenance and operation for the life of the project. It sounds complex, but I assure you that we have found it easier and more economical than the older methods.

Radioactive Bench Marks for Subsidence Study

A SYSTEM of radioactive bench marks is being used in oil-well bore-holes by the Long Beach, Calif., Harbor Department to aid its study of subsidence in the Long Beach area. The subsidence has approached a rate of 1 foot a year in some locations. Opinions differ as to the cause of this movement.

Some of the suggested explanations include: (1) the consolidation of shales adjacent to oil-producing sands in the oil field underlying the area; (2) the consolidation of the producing oil sands; and (3) the effect of tectonic forces.

The bench marks have been placed at significant horizons in underground strata so an indication can be given regarding which of the strata are consolidating and causing the subsidence. This information should permit a more accurate analysis of the subsidence cause to be made than has been feasible up to this time.

The equipment used was specially developed in oil-well work for perforating casings and has been in use for a number of years. However, this is believed to be the first application in consolidation studies. Bullets, each containing a small pellet of a radium salt (half-life 1,600 years), were fired into the wall of the oil well bore prior to casing operations. The location of the bullets are indicated by use of a Geiger-counter type of instrument suspended on a steel cable and lowered into the well.

Later, when it is desired to remeasure the location of these bullets, this can be done in a similar manner. Such measurements are made by temporarily suspending operation of the well or during periods of shutdown for maintenance, repairs or inspection.

Measuring equipment is accurate to less than 1 foot. Because of this limited accuracy, it may take a number of years to get a fair indication of the particular strata that are consolidating. However, it is planned to check the location of the bench marks at least once each year.

Such bench marks were installed in four wells in the Long Beach area. About 20 of them were placed in each well at depths varying from 100 feet to 5,900 feet. —*Engineering News-Record*, April 29, 1948.

Fee Ownership Mapping in Texas

By ZILMON J. BOOTHE, JR.*
CHIEF ABSTRACTOR, JACK AMMANN PHOTOGRAMMETRIC ENGINEERS

FEE OWNERSHIP MAPS, utilizing controlled aerial-photograph mosaics as a base, have been used to advantage for more than 15 years by the various major oil companies operating in Texas and the Gulf Coast area. In like manner, maps of this type have proven their worth innumerable times to county, city, and state governments, U. S. District Engineer offices, and other organizations. By its very nature, the work of compiling land ownership maps involves frequent "headaches" as well as humorous incidents. On the lighter side, I always enjoy telling of the incident which occurred back in 1938, while compiling a fee-ownership map for a county located some 150 miles south of San Antonio, Texas. This actually happened, and it goes something like this:

While making arrangements with the County Clerk for space and access to the public records in his office, we noticed one of the more curious local citizens listening rather intently to everything that was said. Two or three days later we again saw this same citizen in the coffee shop across from the courthouse. He greeted us with: "You fellows still here?" We replied: "Yes, we expect to be here for three or four months longer."

He then demanded: "What business you in?" We answered: "The aerial survey business."

He thought about this for a few minutes, then said, "I see." But obviously he didn't "see" at all, for his next sally was: "My goodness! Is it going to take you *that long* to survey *all the radio aerials in town?*" Only then did it dawn on us that the County Clerk had a radio in his office with an outside antenna or aerial which stretched across the courthouse lawn. To this man the word "aerial" could have only one possible meaning, and that was in connection with a radio.

ORIGINAL SPANISH AND MEXICAN SURVEY DESCRIPTIONS

Many of the descriptions of original Spanish and Mexican land grants were quite vague, probably owing in part to lack of suitable measuring instruments for the original surveys. Vague descriptions, of course, are the bane of property mappers, causing them many a "headache," much loss of sleep, and general consternation. However, these old descriptions were the cause of much humor also, as I demonstrated in an article published in the June 1943 issue of *Photogrammetric Engineering*, which contained the following interesting description:

. . . . Thence, in a northerly direction, three cigarettes on a burro, to the waters of the Escondido Creek, ... sufficient to contain acreage adequate for pasturage of 500 head of cattle. . . .

The Spaniards, of course, were not attempting to be humorous. In their day and time, this type of description was acceptable and understandable to them,

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and served their purpose. Land was plentiful, and surveying instruments, if any, were crude and highly inaccurate. The Spaniards invariably added, for *pilon*,[1] more acreage than was originally allocated for the grant or survey. This is illustrated in the quotation below, taken from the article entitled "Relocating Land Surveys in Texas," by B. F. Williams, State Reclamation Engineer, Austin, Texas, published in the November 1930 *Proceedings, American Society of Civil Engineers:*

Indefiniteness in description and inaccuracy in laying down the original boundaries cause most of such litigation. As an example the following is cited from the archives of the Texas General Land Office:

In the same Town on the same day, month, and year that precedes, Don Juan de la Garza and Don Pedro de Salvana, the Surveyors, the former on the part of His Majesty and the latter on that of the Town, came into our presence and said: That in conformity with the Act made known to them on the third, they proceeded to mark out the boundaries assigned to the Town on the South, and using the cord composed of fifty Mexican varas[2] recognised by the Commissioners present, they stretched the same one hundred times (beginning at the center of the Town) which make five thousand Mexican varas or one complete league, with which they arrived at the point known as La Cantera, which they marked out; with as many more they reached a vale with woods which are transitable and which is named the stopping place called Senor San Jose; with as many more the gully at the foot of the hills of Los Quatitos and they dedicated it to our Senor of San Juan; with as many more to the stopping place called Agua-pas and dedicated it to our Lady of La Sotemano; with as many more to a hollow in front of Abra del Quemado which they dedicated to our Lady of Dolores; with as many more to the margin of the River Blanco which they dedicated to our Lady of Loreto, and they are the six leagues which in accordance with the order communicated to them they have surveyed and marked out, each league for itself on said course. And from said plain they returned to the Town and directing themselves to the North from its center, they stretched the cord one hundred times and arrived at the Palitos Blancos and dedicated it to our Lady of Santa Ana; and with another hundred cords commencing on the other bank of the Rio Grande del Norte (for the reason that but a few varas remained between the said league and the river) they arrived at a hill which they dedicated to San Joachin and marked out the second league; with as many more to an opening in the hills (Abra) called El Yachupin which they dedicated to San Francisco de Borja; with as many more to the end of said opening in the hills to the place called San Lorenzo; with as many more to the opening in the hills of San Yldepfonso which they dedicated to Santa Theresa de Jesus; and with as many more to a hill which is on one side of the stopping place called San Yldepfonso which they dedicated to La Santissima Trinidad, which six leagues they surveyed and marked out in the same manner as those above specified, always following the said course, North. And this is what they did in compliance with their duties, and without having anything to add, they signed with us and those of our assistance. = Palacio = Lizos Ossino = Juan Jph de la Garza Falcon = Pedro Joseph Ygnacio de Salvana = of Assistance, Duran. = of Assistance Federico Losada.

Such deficiencies as these are the causes of the greatest difficulties to the surveyor making a relocation.

The last statement of this quotation holds equally true for the map maker

[1] *Pilon*, an old Spanish expression meaning *for good measure, extra at no cost*, like a *baker's dozen*, etc.

[2] *Vara*, a Spanish measure of length, equivalent approximately to 33⅓ inches, or 1900.8 varas equal 1 mile.

who attempts to compile a composite property-ownership map from notes similar to those quoted above.

After Texas became a republic, surveying of the public domain was begun under severe handicaps, such as primitive transportation and frequent encounters with roving bands of hostile Indians. Land surveying in Texas at that time was not only dangerous—in many instances it was almost impossible. This led some of the surveyors of that period to adopt the practice of making sketches of fictitious surveys (sometimes referred to as "office-surveys"), with witness corners regularly described by such vague phrasing as: . . . to a mound of earth for corner; . . . to a stalk for corners;. . . to a mesquite tree (*no hacks or blazes mentioned and there are millions of mesquite trees in Texas*); for corner; . . . to a pile of rock for corner; . . . to a pile of buffalo bones for corner; etc. These original "survey notes" were then filed in the General Land Office at Austin, Texas, with certification stipulating that the survey had actually been located and run out on the ground, even though, on all too frequent occasions, the survey was principally a product of the imagination. Original surveys and tract descriptions such as have been described are, of course, the primary causes of land-ownership discrepancies, including *excess, overlap,* and *vacancy*. A map compiler working strictly from the patent notes of original surveys and grants, along with field-note descriptions of subdivisions thereof, may be able occasionally to plot individual descriptions on paper or cloth. However, the few tracts which would plot, would usually not depict actual property occupation on the ground, and furthermore, the plotted tracts could seldom be matched together to form an accurate composite property map. Thus it was a natural development, as air-photograph mosaics became available, that their advantages and economy as a base for property-ownership maps would be recognized and utilized. The air-photograph mosaic is a miniature facsimile of the earth's surface, brought in to the office, where may property boundaries can be immediately identified, and traced out. These can then be used as base lines for adjusting in the plots of the unidentifiable boundaries, using recorded descriptions and survey notes as far as possible. The end-product is comparable to what would have resulted from an actual ground resurvey of each and every parcel of land in the project. It is a complete and thorough audit of the ownship of the lands within the area mapped.

USE OF CONTROLLED AERIAL MOSAICS

Over the years, many refinements have been made in the procedures of compiling fee-ownership maps which are built up on controlled mosaics. To construct this type of mosaic requires first that all of the government-survey triangulation stations be located in the field, and identified on photographs. If there are not enough government-survey stations in the mapping area, additional field surveys must be run to assure an over-all scale accuracy of 1 percent in the mosaic. The mosaic base is then prepared in the office in the usual manner. All of the control points are plotted on hardboard original map sheets, on any projection, and to any desired scale. A radial-line control plot is prepared, by any of the conventional methods. Each air-photograph print is then ratioed and rectified to the positions shown on the radial-line control plot. Finally, the assembly of the rectified prints on the control plot must be done with the utmost care and precision. Any kind of a mosaic will not do for this purpose—it has

to be accurate as specified, an actual miniature facsimile, or the property-ownership discrepancies cannot be worked out satisfactorily.

After the mosaic is complete, the work of plotting the property boundaries is begun. All evidences of property occupation, such as fences, roads, and streams, are compared with property tract descriptions. Those features which are actually property boundaries usually can be rather readily identified. Where there is doubt, a field verification is required. All remaining boundaries, not directly discernible on the mosaic, are then plotted and adjusted thereon from field-note descriptions, again verifying in the field where discrepancies appear. Political subdivision boundaries, such as county lines, are plotted in a similar manner. When the entire property-line net is complete on the mosaic, the information desired for the ownership map is traced on to acetate sheets, and the necessary lettering added.

ADVANTAGES OF STATE PLANE COORDINATES

The adoption of state-wide plane coordinate systems by several states indicates a growing awareness of the need for doing something about permanently preserving the locations of land boundaries and corners. This same awareness will also create widespread demand for property-ownership maps constructed by methods similar to these described herein. Where a state coordinate system is already in use, the preparation of land-ownership maps is usually expedited. Where the state coordinate system is adopted after the ownership map is made, there will be no difficulty in correlating the coordinate system and the base mosaic, provided the mosaic was accurately compiled originally.

Lieut. Commander O. S. Reading, on the occasion of his retirement as President of the American Society of Photogrammetry in 1938, spoke on "Air Photography and Adequate National Surveys." With respect to the value of state-wide plane coordinate systems, he stated his views as follows:

> . . . . When the closely spaced control stations on plane coordinates and the large-scale, cadastral-topographic maps become available, it will be practicable to initiate a system of voluntary land registration whenever title changes hands. A first-class system of this sort saves so much in legal and title-guarantee fees that its eventual adoption is inevitable by all intelligent people. . . .

Frank Emerson Clark, in "A Treatise on the Law of Surveying and Boundaries," published by the *Bobbs-Merrill Company*, gives his views on this subject as follows:

> . . . . The entire case for the use of plane coordinates is well summed up in a progress report prepared by a joint committee of the Real Property Division, American Bar Association, and the Surveying and Mapping Division, American Society of Civil Engineers. The report is entitled: "Land Surveys and Titles" and was printed in the *Proceedings, American Society of Civil Engineers* in November 1938. The following passages are from that report. The secretary of the joint committee which prepared it is Professor A. H. Holt, Worcester Polytechnic Institute, Worcester, Massachusetts.
>
> The Committee finds further that, in order to provide proper reference marks for fixing position and direction, a system of survey monuments should be established, connected by properly controlled precise surveys, and that the positions of these monuments, so determined, should be expressed in terms of a coordinate system, preferably by plane rectangular coordinates. Descriptions of the monuments, together with their coordinates, must be recorded by some public authority and the record made available for public use.

MATCHING 7½ MINUTE GRID CELLULOID DETAIL SHEETS

One step in the preparation of a fee-ownership map, using controlled aerial-photograph mosaics as base.

'The United States Coast and Geodetic Survey has developed a plan for the establishment of such interrelated monuments and systems of plane coordinates for defining positions. This plan has already been put in operation in several states and has won the immediate approval of practicing land surveyors and title examiners. Many thousands of monuments have been set and their coordinates have been determined. The plan is known as the "State System of Plane Coordinates." It has been thoroughly studied by the members of the Committee, and it is believed to offer an adequate remedy for the deficiencies described. The utility of the plan extends to so many fields other than that of land surveys and descriptions that the cost to the taxpayer for its adoption will be returned manyfold. It provides a basis for checking and controlling instrumental and aerial surveys for maps and plans required for all engineering development. The time and cost of establishing special control for each project are thus obviated. Furthermore, all existing data can be compiled, and boundary lines can be correlated without field determination. . . .'

SUMMARY

Although the foregoing describes briefly the conditions and techniques pertaining to fee-ownership mapping on mosaic bases in Texas, it seems obvious that similar procedures could be utilized advantageously for similar work almost anywhere in the United States. True, in those states which are subdivided into townships, ranges, and sections, the work should not be as complicated or as involved as fee mapping in Texas. Even in those states, however, many irregularities do occur, along all correction lines, and in the so-called "large sections," "short sections," etc. Moreover, it must be borne in mind that "office-surveying" was practiced extensively in many areas of township and range subdivision, as well as in the State of Texas, and in most cases for the same reasons. This practice, of course, also has been the cause of many serious irregularities and discrepancies in those states, just as it was in Texas. The experience of the extensive program of fee-ownership mapping in Texas indicates that, regardless of how bad the ownership records may be, the utilization of a controlled aerial-photograph mosaic as a base map will usually provide a satisfactory and economical method of getting good property-ownership maps anywhere. If the state plane coordinate system is in use, so much the better, for then the mapping work will be expedited, and the ability to recover exact locations of boundary lines and corners at any future time will be assured.

Remember

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Aerial Photographs in Forest Surveys

By RAYMOND D. GARVER

DIRECTOR, NATION-WIDE FOREST SURVEY, U. S. FOREST SERVICE

ABOUT 70 percent of the United States has been photographed from the air. Farmers, foresters, and other workers in agriculture are familiar in a general way with the use of aerial pictures in programs having to do with soil conservation, timber conservation, and farm crops. The photographs have many more possible uses and values. In forest surveys they give us a vast amount of information on area and location of forests, the volume of timber, the kind, condition, growth, and depletion of the stand on account of cutting, and losses caused by fire, insects, and disease.

SOME STEPS IN USE OF AERIAL PHOTOGRAPHS IN FORESTRY

Aerial photography came into practical use in the first world war and was of outstanding service in the second. Improvements in airplanes, cameras, and techniques in taking the pictures have made remarkable progress, but from the standpoint of making a timber inventory, there is much yet to be worked out. Among the pioneers in using aerial pictures for mapping purposes in the United States was Lage Wernstedt, who made a topographic map of a western national forest in 1917, largely from photographs. By 1920 foresters in Canada were using photographs to map forest types. By 1929 the Canadian Dominion Forest Service and others were making rough estimates of volume as well as area of timber. In the middle 1930's foresters at the California Forest and Range Experiment Station were working with aerial photographs to survey vegetation types and timber. In 1940 a firm of consulting foresters used aerial photographs to supplement a ground cruise of a redwood timber tract in California.

In 1941 the Northeastern Forest Experiment Station used photographs and a modification of Canadian methods to make a forest survey of the Anthracite region of Pennsylvania. Two years later a pulp and paper company in New England had its holdings photographed from the air to provide pictures for use in cruising their timber and in preparing a management plan. By 1944 the use of aerial photographs for timber surveys was being considered more widely, but many questions regarding technique and accuracy remained unanswered.

At this point Harvard Forest, Petersham, Mass., in co-operation with the Northeastern Forest Experiment Station, the California Forest and Range Experiment Station, and several other agencies began preliminary experiments to determine such things as types and scales of photographs best suited to timber surveys, most usable kind of film and filter, methods of classifying and identifying species and of measuring tree heights and volume, and the development of instruments to transfer timber information from photographs to base maps. The results from these limited experiments are gratifying and when compared to old methods indicate the possibilities of continuing research on a broad scale.

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Acknowledgment for assistance in the preparation of this article is made to the men engaged in Forest Survey work at the California, Northeastern, and Southeastern Forest Experiment Stations.

For years foresters and landowners have been looking for improved techniques and methods of making timber inventories. There is a recognized need to speed up inventory work, often called timber cruising, get more detailed information, reduce ground work, and lower costs per acre. Increasing availability of aerial photographs and new discoveries in photographic techniques, films, and cameras, together with improved forest survey methods, hold promise in achieving these objectives.

Such developments are of special concern to the Nation-wide Forest Survey, which has covered about half the forest land of the United States. Some 300 million acres of forest land, occurring brokenly in 33 states, remain to be surveyed. This gives some idea of the magnitude of the job and the importance of improved techniques that will provide a partial substitute for walking over the land to study the timber as is necessary in ground cruising. After the initial survey, the continual change in forests on account of depletion and growth requires periodic rephotographing and recruising to keep the timber information up to date. Current pictures are necessary for best results in both initial and maintenance surveys.

FOREST SURVEY METHODS

A survey without photographs of a forest area necessitates examining the land and timber on foot. Since it is impractical to inspect every acre, the usual procedure is to measure the trees on well-distributed sample plots or strips and then increase the results to the magnitude of the total area. For example, if 5 percent of the area is included in the plots, then multiplying the volume of timber on them by 20 gives the volume for the entire area. Obviously this method leaves much to be desired. What improvement can be made if photographs are used to supplement and implement the ground work?

The aerial photographs permit the forester to see the forest area just as he could if he were suspended over it. From them he can prepare a map showing the location and area of forested land and other land and limited details about the timber. This is much better than mapping the area from sample plots and observations made while tramping through the woods. But on the other hand, ground observations and measurements disclose information not obtainable from photographs, such as species identification and stand composition, quality of timber, cull, growth rate, seedling and sapling counts, and a tally of under-story timber not visible from the air.

Precise measurements of timber height and diameter are also needed to check similar information obtained from photographs. While exact and proved procedures have not been developed, present indications are that a combination of ground work and aerial photographs will be the most satisfactory. As time goes on, however, aerial photographs will play an increasingly important part in forest surveys, but never wholly eliminate the need for ground work. A brief discussion of a few questions that arise in interpreting aerial photographs will explain some of the potentialities and difficulties in their use.

The type of film used for aerial photographs has an important bearing on the value of the pictures in forest surveys. Panchromatic film has been used the most widely and is satisfactory for measuring tree heights and other detail, but it does not permit satisfactory differentiation between hardwoods and softwoods or between species. To overcome this deficiency some use has been made of the infra-red film, which brings out the contrast between hardwoods and softwoods in

summer photographs. As a further improvement, Harvard Forest tried this film with a minus blue filter in southern pine. The results were encouraging. Tone contrasts between forest types and species were improved over panchromatic photographs, and sharpness of detail was not seriously impaired. In general, the softwoods were dark to gray in color and the hardwoods light to very light gray. Not much use has been made of color film so far, and results were mediocre. Theoretically, it seems to have good possibilities. For example, photographs of the Appalachian hardwoods in the fall when the leaves are at the height of their color should make identification easy on a number of species. Widespread use is limited by comparatively high costs, processing limitations, and variability of details on color film exposed at high altitudes, but future developments in technique or in film may permit its use in forest surveys.

Next in importance is the original scale of the photograph. The most useful scale for timber work has not been determined. Quite probably it will vary by types and kinds of timber. The Forest Service is making a special study to determine whether one scale, and which one, will satisfy the needs both of forest surveys and of engineering mapping work. Many foresters prefer photographs on a scale of 4 inches to the mile, the equivalent of contact prints from original negatives at a scale of 1:15,840. The scale most widely used in land and timber resources work in the past has been about $3\frac{1}{6}$ inches to the mile, or 1:20,000. Scales between 1:12,000 and 1:22,000 roughly indicate the range in which photographs can be used for forest survey purposes. While the scales of photographs being used in forestry are both smaller and larger than those, for forest survey purposes it is believed that most satisfactory results, considering both accuracy and speed, will be had from the scale of 4 inches to the mile for most types and species of timber. In general, the more broken up and spotty the timber types and areas, the greater the need for the detail observable in large-scale photographs. A word of caution in using scales for determining distances on aerial photographs is necessary. Scales are not precise because the mechanics of taking the photographs are subject to inherent disturbing influences. Variations in altitude, tilt, and tip of the airplane may cause as much as 10 percent error in area determinations for individual photographs, but may be compensating for a number of photographs. The variations in elevation of the area being photographed also make a difference in the scale of the photographs.

A third factor influencing the usefulness of aerial photographs is the time of the year when they are taken. This is not fully resolved for forest surveys on account of many variables, such as stand mixtures, special information requirements, color variations of leaves as influenced by altitude, and seasonal weather conditions. Early spring or fall are probably the best seasons, all factors considered, to photograph an area for forest survey purposes.

Interpretation of aerial photographs in forest surveys means getting all the information possible from them. Of special help in doing this is familiarity with timber, including species, normal mixtures for the various types, general shape of the crowns of dominant trees, and a knowledge of forestry such as a technical forester usually possesses. One step in this analysis is to transfer the forested area shown on the photographs to a planimetric base map. A method of doing this is by means of a vertical reflecting projector which throws an image of what is on the photograph onto a base map. After adjusting the scale of the picture to fit the map, the forest area can be readily outlined on the map. Another

method is to outline the types and classify the stands on the photographs before transferring the information to the base map. Other instruments for transferring and interpreting the information shown by the photographs to base map are the radial planimetric plotter, KEK plotter, the duoscope, multiscope, and sketch master.

Examination of overlapping pairs of photographs under a stereoscope is necessary to obtain the maximum information from them. This instrument makes it possible to see and measure the three dimensions of clearly defined objects on the photographs and with good magnification it is indispensable in interpreting them.

With those and other simple instruments, reasonably accurate measurement of four different factors is possible. These are height of individual trees or stands, number of trees per quarter acre or other unit of area, diameter of crowns of dominant or codominant trees, and proportion of the area occupied by timber. By analyzing this information, an experienced person can classify the timber stands outlined on the photographs into generalized height, volume, and size classes, roughly estimate the total volume, and within limits, identify forest types and species. It is also possible to outline homogeneous forest areas; this greatly facilitates sampling for inventory purposes and should reduce the amount of ground work necessary for an accurate and complete forest survey.

It seems unlikely now that the technique of aerial photography and interpretation will ever reach a point where complete, precise forest surveys can be made independent of ground work. Future changes will probably be along the line of adjusting the ground examination to fill in the deficiencies of the aerial photographs. But whatever the developments, foresters mean to remain alert to their possibilities in improving the work.

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THE NEW ZEALAND INSTITUTE OF SURVEY DRAUGHTSMEN

This organization was founded in 1945 to assist the development of survey draughting and computing, to maintain the rights, privileges, and status of members, and to provide means of expressing technical and other matters of interest to members.

Membership is open to all persons engaged in the profession who are qualified by examination or by long experience, and associate membership is provided for other persons in the profession who are not so qualified. Membership is to be obtained through the constituent branches.

The Institute publishes an excellent and attractive Journal.

Surveyors Filing System

By FORREST DANIELL
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THE AVERAGE civil engineering or surveying office does not require an extensive filing system. However, administrators and office engineers should be provided with basic practices and procedures pertaining to current filing which can be adapted to local requirements. It is hoped that this article will stimulate new ideas toward improving existing filing methods employed in an engineering office, serve as a guide in the installation of files resulting from new activities, and aid in the training of file clerks.

I. THE INSTALLATION OF FILES

1. *Location of files.*—The physical location of the files will depend upon the scope of the organization using the files, particularly as to whether the organization functions solely for engineering and surveying or as a subdivision of numerous types of organizations. It is likewise dependent upon whether the organization maintains offices on different floors of the same building, offices in different buildings in the same city or in different cities. The location of the files will also depend upon the size, functions, and character of work of an installation.

2. *The use of multiple vertical filing cabinets.*—For the average engineering and surveying office, legal size vertical filing cabinets are desired for accurate filing because of the following advantages:

(*a*) They insure the safekeeping of correspondence, folded maps, field notes, calculations, loose-leaf notes (taken in the field), statements, reports, and other documents.

(*b*) Records may be arranged in such a manner that they can be readily found and removed for inspection, and returned to their proper position for future reference, without disturbing other papers.

(*c*) Other documents or papers may easily be added to the file from time to time.

The papers composing an individual file may be placed in a heavy manila folder. The back of the folder should be half an inch higher than the front, to provide for visibility of identification label. Folders holding many papers should be of the expanding end type. If there are many folders covering a certain original survey or survey area, a colored guide should be inserted, to aid in their rapid and accurate location. Each county should also have a different colored guide. These guides are usually made of heavy cardboard with eyelets in the bottom so that a rod may be run through to prevent the removal of the guides from their proper positions in the filing cabinet. Celluloid tabs containing the name of the county or survey are placed on the guides to make it easy to find the individual files.

3. *Geographic filing.*—The arrangement of material according to geographical location is ultimately coordinated in an alphabetical order as outlined below:

(*a*) *Name of county.*
- (1) Name of original survey, township or area surveyed.
  - (*1a*) Name of tract (ownership) or subdivision.
- (2) Name of incorporated towns or cities.
- (3) Name of project.

4. *Alphabetic filing.*—The alphabetic filing of correspondence with firms, government agencies, and individuals, which because of its nature can not be filed in the geographical filing system, should be observed. Correspondence containing information bearing on surveys in all its ramifications should, if possible, be inserted in the geographical arrangement. In some cases, papers filed in the alphabetic filing cabinets should later be transferred to the survey files.

5. *Contents of a survey file.*

(*a*) Letter of authorization of survey to be made.

(*b*) Copy of letter of acceptance, outlining extent of activities, the date survey will be started, and sometimes the cost thereof.

(*c*) Photostatic or typewritten copies of Land Office field notes.

(*d*) Copies of lease or ownership tract description.

(*e*) Abstract maps, Land Office maps, etc. (folded prints).

(*f*) Computation sheets of coordinates and areas, etc.

(*g*) Correspondence in connection with the survey.

(*h*) Survey reports with a copy of the survey plat or plats.

(*i*) Loose-leaf field notes (taken in the field).

(*j*) Statement of the cost of the work performed.

(*k*) Field note description of each tract surveyed.

6. *Filing survey maps.*—Ordinarily folded paper prints of maps are placed in the vertical filing system, the detailed (hard-copy) maps, tracings, vandykes, and other large maps are given numbers and filed in cardboard tubes or flat drawer cabinets. An index book of these maps should be listed in a geographical arrangement similar to that used in vertical filing. Each listing should include the following:

(*a*) Number.

(*b*) Title of map designating location.

(*c*) County map coordinates.

(*d*) Scale and size of map.

(*e*) Type of map (detail, tracing, print, lithograph, photostat, etc.).

(*f*) Name of draftsman, surveyor, firm or agency issuing map.

(*g*) Date of survey or map.

7. *Filing catalogs, publications, bulletins, etc.*—Engineering and surveying offices should maintain files of certain specialized types of material, other than correspondence, survey reports, field notes, and maps. These specialized files are composed of catalogs, government publications, mapping and surveying journals, bulletins, and various types of survey blank forms, and are usually set up as separate files. Arrangements suggested for this type of material are as follows:

(*a*) *Catalogs.*—These are arranged alphabetically by name of manufacturer, contractor, or supplier. Book catalogs should be placed in bookcases or on shelves. Pamphlet catalogs should be filed in folders and placed in a vertical cabinet, a folder for each catalog. Whenever a new issue of a catalog is received and filed, the obsolete copy should be destroyed. A file and cross-reference may be made on index cards or in an index book under the catalog listing.

(*b*) *Publications, circulars, bulletins, manuals, etc.*—Publications of book size should be placed in bookcases or filing cabinets, two rows of publications to a drawer. Pamphlet publications should be maintained loose in folders placed in the filing cabinets. A file of publications should be filed alphabetically by type of publication. Sometimes in addition

to the publication file, a copy of a publication which directly affects a particular survey or subject heading may be filed in the subject file instead of cross-indexing.

(*c*) *Blank forms and stationery.*—Sample blank forms with directions for their use may be filed under the heading "blank forms and stationery." These forms include the various application and field-note forms issued by the General Land Office, latitude and departure blanks, personnel forms, etc. Surplus supplies of blank forms and stationery may be stored on shelves in the stock room or filed vertically in the file cabinets.

8. *Index of individual survey file.*—Since the contents of an individual survey file varies as to the number of items contained in the folder, it is recommended that an index be maintained in connection with the file.

II. FILE ROOM SERVICE

1. *Request for a particular file.*—The following suggestions for handling requests of papers and maps on file and the charging out of material are primarily for the use of interdepartmental organizations. General information in the files, requested by persons outside of the organization, should be charged out and removed from the files only by authorized officials. When removed the papers or maps should be photostated for transmission and the originals returned to the file room. The file clerk should be instructed to obtain complete identifying information before the person requesting the file material breaks telephone connection or leaves the file room. Requests for file material should be written on the charge-out form which should contain the following items with sufficient space under each item for the required information:

(*a*) Subject or survey and county.
(*b*) Writer (organization, individual, surveyor, etc.).
(*c*) Addressee (organization, individual, etc.).
(*d*) Approximate date of paper or map.
(*e*) Requester's name, office, room, and telephone number.

2. *Finding the file.*—The file clerk in handling a request for a file usually checks:

(*a*) The classification of the instrument or map requested.
(*b*) Other classifications under a similar subject or survey.
(*c*) Cross-references.
(*d*) Files and maps being prepared.
(*e*) Charge-outs.
(*f*) Nearby desks (persons momentarily using file without charge-out).
(*g*) The file for completeness and arrangement.

In case the file clerk can not readily find the desired file, a check of the folder or section before and after the guide where the information should be located may reveal the missing folder.

3. *Charge-Out.*—All material removed from the files should be replaced by a charge-out form. A charge-out form that projects above the folders is recommended because it acts as a signal for refiling borrowed papers and furnishes a visible check on all records which are charged out of the file. A carbon copy of the charge-out form is placed in the follow-up file for tracing purposes.

Some organizations use gay-colored cards for its various subdivisions as charge-out forms. These cards, used both for correspondence files and map files,

are kept in a box partition placed upon one of the cabinets. Ordinarily this substitution card is satisfactory. Its weak point is that an entire subdivision of an organization and not any particular individual may be responsible for the removed file or map.

4. *Return of borrowed papers or maps.*—Papers or maps returned to the files should be carefully checked for unrelated papers that may have become attached. The charge-out form sheet is removed from the files and its copy removed from the follow-up file. Both charge-out forms should be destroyed, but only after the file is checked as complete.

REFERENCE

WAR DEPARTMENT TECHNICAL MANUAL TM 12–258. *Records Administration Filing Procedures, U. S. Government Printing Office, Washington, D. C., 1945.*

* * *

New IBM Electronic Calculator

THE new IBM Selective Sequence Electronic Calculator was recently dedicated "to the use of science throughout the world" by T. J. Watson, president of International Business Machines Corporation, at special ceremonies at the company's headquarters in New York City. Incorporated in this huge machine, which occupies a specially designed room, are facilities which have been hitherto unavailable; an adequate means of getting data and procedure instructions into the machine and of getting results out of it; a gigantic memory capacity for storing huge masses of numerical detail which accumulate in the process of calculation; and a highly flexible means of guiding the flow of numbers through all phases of the calculation.

The new calculator possesses about 250 times the productive capacity of the Automatic Sequence Controlled Calculator presented to Harvard University by IBM in 1944. Memory capacity is 400,000 digits; reading speed from punched tapes, 140,000 digits a minute and from punched cards, 30,000 a minute; recording speed by printing, 24,000 digits a minute and in punched cards, 16,000. The computing speeds are perhaps the most outstanding feature: 3,500 additions or subtractions a second of 19-digit numbers; 50 multiplications a second of 14-digit numbers; and 20 divisions a second of 14-digit numbers. The machine contains 12,500 electronic tubes, 21,400 relays, and 40,000 pluggable connections. In operation, the machine reads the numbers involved in a problem as well as instructions that have been prepared for its solution. It consults its own reference tables containing the results of previous calculations. A "Central nervous system" directs the sequence of operations from the initial "feeding" of data and instructions into the machine to the final recording process.

W. J. Eckert, who with his staff, was in large part responsible for the establishment of specifications, will direct the research program planned for the calculator. Dr. Eckert is director of IBM's Department of Pure Science and of the Watson Scientific Computing Laboratory at Columbia University.—*Science*, February 27, 1948.

The Principles of Poor Writing

By DR. PAUL W. MERRILL
ASTRONOMER, MOUNT WILSON OBSERVATORY

BOOKS AND ARTICLES on good writing are numerous, but where can you find sound, practical advice on how to write poorly? Poor writing is so common that every educated person ought to know something about it. Many scientists actually do write poorly, but they probably perform by ear without perceiving clearly how their results are achieved. An article on the principles of poor writing might help. The author considers himself well qualified to prepare such an article; he can write poorly without half trying.

The average student finds it surprisingly easy to acquire the usual tricks of poor writing. To do a consistently poor job, however, one must grasp a few essential principles:

I. Ignore the reader.
II. Be verbose, vague, and pompous.
III. Do not revise.

Ignore the Reader

The world is divided into two great camps: yourself and others. A little obscurity or indirection in writing will keep the others at a safe distance; if they get close, they may see too much.

Write as if for a diary. Keep your mind on a direct course between yourself and the subject; don't think of the reader—he makes a bad triangle. This is fundamental. Constant and alert consideration of the probable reaction of the reader is a serious menace to poor writing; moreover, it requires mental effort. A logical argument is that if you write poorly enough, your readers will be too few to merit any attention whatever.

Ignore the reader wherever possible. If the proposed title, for example, means something to you, stop right there; think no further. If the title baffles or misleads the reader, you have won the first round. Similarly, all the way through you must write for yourself, not for the reader. Practice a dead-pan technique, keeping your facts and ideas all on the same level of emphasis with no telltale hints of relative importance or logical sequence. Use long sentences containing many ideas loosely strung together. *And* is the connective most frequently employed in poor writing because it does not indicate cause and effect, nor does it distinguish major ideas from subordinate ones. *Because* seldom appears in poor writing, nor does the semicolon—both are replaced by *and*.

Camouflage transitions in thought. Avoid such connectives as *moreover, nevertheless, on the other hand.* If unable to resist the temptation to give some signal for a change in thought, use *however.* A poor sentence may well begin with *however* because to the reader, with no idea what comes next, *however* is too vague to be useful. A good sentence begins with the subject or with a phrase that needs emphasis.

The "hidden antecedent" is a common trick of poor writing. Use a pronoun

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to refer to a noun a long way back, or to one decidedly subordinate in thought or syntax; or the pronoun may refer to something not directly expressed. If you wish to play a little game with the reader, offer him the wrong antecedent as bait; you may be astonished how easy it is to catch the poor fish.

In ignoring the reader avoid parallel constructions which give the thought away too easily. I need not elaborate, for you probably employ inversion frequently. It must have been a naive soul who said, "When the thought is parallel, let the phrases be parallel."

In every technical paper omit a few items that most readers need to know. You had to discover these things the hard way; why make it easy for the reader? Avoid defining symbols; never specify the units in which data are presented. Of course it will be beneath your dignity to give numerical values of constants in formulae. With these omissions, some papers may be too short; lengthen them by explaining things that do not need explaining. In describing tables, give special attention to self-explanatory headings; let the reader hunt for the meaning of P^1r_0.

Be Verbose, Vague, and Pompous

The cardinal sin of poor writing is to be concise and simple. Avoid being specific; it ties you down. Use plenty of deadwood: include many superfluous words and phrases. Wishful thinking suggests to a writer that verbosity somehow serves as a cloak or even as a mystic halo by which an idea may be glorified. A cloud of words may conceal defects in observation or analysis, either by opacity or by diverting the reader's attention. Introduce abstract nouns at the drop of a hat—even in those *cases* where the *magnitude* of the *motion* in a downward *direction* is inconsiderable. Make frequent use of the words *case, character, condition, former* and *latter, nature, such, very.*

Poor writing, like good football, is strong on razzle-dazzle, weak on information. Adjectives are frequently used to bewilder the reader. It isn't much trouble to make them gaudy or hyperbolic; at least they can be flowery and inexact.

DEADWOOD

Bible: Render to Caesar the things that are Caesar's.

Poor: In the case of Caesar it might well be considered appropriate from a moral or ethical point of view to render to that potentate all of those goods and materials of whatever character or quality which can be shown to have had their original source in any portion of the domain of the latter.

Shakespeare: I am no orator as Brutus is.

Poor: The speaker is not what might be termed an adept in the profession of public speaking, as might be properly stated of Mr. Brutus. (Example from P. W. Swain. *Amer. J. Physics,* 13, 318, 1945.)

Concise: The dates of several observations are in doubt.

Poor: It should be mentioned that in the case of several observations there is room for considerable doubt concerning the correctness of the dates on which they were made.

Reasonable: Exceptionally rapid changes occur in the spectrum.

Poor: There occur in the spectrum changes which are quite exceptional in respect to the rapidity of their advent.

Reasonable: Formidable difficulties, both mathematical and observational, stand in the way.

Poor: There are formidable difficulties of both a mathematical and an observational nature that stand in the way.

CASE

Reasonable: Two sunspots changed rapidly.

Poor: There are two cases where sunspots changed with considerable rapidity.

Reasonable: Three stars are red.

Poor: In three cases the stars are red in color.

RAZZLE-DAZZLE

Immaculate precision of observation and extremely delicate calculations. . . .

It would prove at once a world imponderable, etherealized. Our actions would grow grandific.

Well for us that the pulsing energy of the great life-giving dynamo in the sky never ceases. Well, too, that we are at a safe distance from the flame-licked whirlpools into which our earth might drop like a pellet of waste fluff shaken into the live coals of a grate fire.

DO NOT REVISE

Write hurriedly, preferably when tired. Have no plan; write down items as they occur to you. The article will thus be spontaneous and poor. Hand in your manuscript the moment it is finished. Rereading a few days later might lead to revision—which seldom, if ever, makes the writing worse. If you submit your manuscript to colleagues (a bad practice), pay no attention to their criticisms or comments. Later resist firmly any editorial suggestions. Be strong and infallible; don't let anyone break down your personality. The critic may be trying to help you or he may have an ulterior motive, but the chance of his causing improvement in your writing is so great that you must be on guard.

FINAL SUGGESTIONS FOR POOR WRITING

Do not read:

ALLBUTT, CLIFFORD. *Notes on the Composition of Scientific Papers.* Macmillan, 1923.
FLESCH, RUDOLF. *The Art of Plain Talk.* Harper, 1946.
GRAVES AND HODGE. *The Reader Over Your Shoulder.* Macmillan, 1943.
QUILLER COUCH, ARTHUR. *On the Art of Writing.* (V). Putnam, 1928.
Suggestions to Authors of Papers Submitted for Publication by the United States Geological Survey. U. S. Government Printing Office, 1935.

Educated Man

FIVE standards can identify the educated man: (1) ability to use and understand his native tongue in speech or writing, in order to convey his ideas and thoughts clearly and effectively to others; (2) ability to judge, compare, evaluate, in short to criticize objectively the ideas, thoughts, and conceptions of other men; (3) knowledge of men and their affairs; (4) knowledge of the physical world and the universe in which he lives, meaning of course some understanding of the laws and forces of nature, ranging from astronomy to bacteriology; (5) knowledge of a profession or a vocation for the purpose of earning a living and serving God and society as a competent and morally responsible individual.—Arthur C. Willard, President Emeritus, University of Illinois in *Engineering Experiment Station News,* The Ohio State University, February 1948.

MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession. —EDITOR.

Mississippi River Maps

A BOUND FOLIO of general navigation maps of the Mississippi River from the Mouth of the Ohio River at Cairo, Illinois, to the Gulf of Mexico, Louisiana, has been issued by The Department of the Army, Corps of Engineers, Mississippi River Commission. Republished annually, this set is the 16th (1948) edition and supersedes all editions subsequent to 1933. Sixty-two detail maps of 1 : 62,500 scale supply various types of information. Geodetic positions are referred to North American Datum, polyconic projection. Early meander lines are shown, together with 5-mile river distances referred to Head of Passes (approximately 100 miles below New Orleans, Louisiana) with circles at 1-mile intervals printed in red. Mileage below Head of Passes with 0.0 mileage at that place for Southwest Pass and South Pass is also shown in red. Other information contained in the detail maps is given in the July–December 1947 issue of SURVEYING AND MAPPING.

In addition to the detail maps, the folio contains a number of supplementary sheets. These include a series of 10 sheets, printed for the first time in this edition, showing plan sketches of the locations of river ports, docks and terminals and facilities pertaining thereto along the Mississippi River from Cairo, Illinois to the Gulf of Mexico.

An alphabetical index in 13 sheets gives mileage and reference to map locations of various geographical and other locations along the river. A map index, scale 1 inch to 8 miles, in seven sheets, shows the Mississippi River proper overprinted in blue and 10-mile river distances in red. A tabulation in 10 sheets gives the project channel dimensions at low water of navigable streams in the Lower Mississippi Valley Division, CE, with data as to navigable depths for various periods of the year.

A profile of the Mississippi River, from Cairo to the Gulf, showing high water, 1927 and 1937, and low water, 1936, and thalweg 1943, is presented, together with maximum and minimum discharge and tabulation of highest and lowest readings at principal gages.

On the reverse side of the cover is a map of the Lower Mississippi Valley Division, CE, scale approximately 1 inch to 40 miles, showing principal rivers and tributaries and Intracoastal Waterway, Gulf Section. This map, dated June 1948, was completely redrafted for this edition and indicates the location of the

principal flood control structures in the Lower Mississippi Valley. The inside of the back cover contains an outline map, scale approximately 7/8 inch to 10 miles, of the Mississippi River from Osceola, Arkansas, to Angola, Louisiana, showing location of cut-offs made since 1929 and tabulation of mileage shortening with navigation through the cut-offs instead of around the bends.

The complete set is priced at $1.00 (individual sheets are not available for sale) and may be obtained by money order or certified check from the Mississippi River Commission, Corps of Engineers, P. O. Box 80, Vicksburg, Mississippi.

Alaska Highway Maps

OF INTEREST to motorists and sportsmen is a new series of four maps of Alaska Highway, covering U. S. connecting highways, all access routes through Western Canada, a complete showing of Alaska, and large-scale detail coverage of all the country adjacent to the connected highway south of Alaska.

The maps are full-color lithographic reproductions, compiled from official, commercial, and private sources. They show all roads, point to point and section mileage, towns, settlements, roadhouses, trails, railroads, lakes, rivers, glaciers, passes, mountains and ranges, parks, boundaries, etc.

Supplementing the maps is a travel information guide containing information about roadside facilities along the Alaskan highways and other information of interest to the tourist. The map assembly is folded to a handy 6- by 9-inch size with the supplemental travel-guide tucked inside and sealed in a tough moisture- and dust-proof, clear, cellophane envelope. When opened the envelope provides convenient map storage.

The complete packet sells for $1.00 and may be purchased from the Northwest Mapping Service, 655 E. 45th Street, Seattle 5, Washington.

County Highway Maps of North Dakota

THE county highway maps of North Dakota are prepared by the State Highway Department of North Dakota in co-operation with the United States Public Roads Administration. Seventy-seven separate maps comprise the series covering the 53 counties of the State. The maps of the present series were published at dates varying from 1936 to 1941. Eleven counties comprising the southwest part of the State were revised from aerial photography in 1940–1941.

Work is now in progress on a general revision of the Nelson county map. The revised edition will be produced on the Lambert conformal conic projection using the Plane Coordinates System devised by the U. S. Coast and Geodetic Survey. A re-inventory of the entire State was started in 1946 and four counties have been completed to date. It is planned to proceed with the work at a rate to insure completion of the project within 5 years.

The many migratory waterfowl refuges of the State are outlined. Airfields are shown by symbols and in some cases runways are outlined and beacons are indicated.

The full-size maps are distributed at cost determined on a square-foot basis. The price of blueline prints ranges from 53 cents to 98 cents depending on size. The reduced size sheets are distributed as litho-prints at 30 cents per copy. A complete set of all lithoprinted sheets bound as an atlas is available at $25.00. Orders should be placed with the State Manager, Highway Planning Survey, State Capitol Building, Bismarck, North Dakota.—*The Military Engineer,* February 1948.

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Cameras and Airplanes Are Photomapping Alaska

A SUMMER-LONG aerial survey of 30,000 square miles of Alaska is now underway, the U. S. Navy revealed. Navy planes and Navy cameras are doing the job. It is being carried out in cooperation with the Department of the Interior and other government agencies.

Data secured from the photographs will be used to determine the waterpower possibilities of the panhandle region of Alaska, which stretches from Skagway to the south. They also will help estimate paperpulp resources of the area. The survey will be of value to civil transportation by air because Alaska is on the Great Circle route from continental United States to points in Asia by way of the Aleutian islands. Alaska is also a valuable take-off point for planes to Europe by the North Polar route.—*Science News Letter,* July 17, 1948.

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Xerography—A High-Speed Printing Process

XEROGRAPHY is a revolutionary process for reproduction of printed matter, drawings and photographs without the use of fluid ink. The process, shown to the Optical Society of America, makes use of static electricity and a dry powder to reproduce pictures, to copy letters or documents, and to print on high-speed presses. Not only does the process eliminate fluid inks used in ordinary printing, it also eliminates the liquids and chemicals of conventional photography.

The basic principle of xerography—from the Greek words "xeros" for dry, and "graphein" to write—is similar to photography in that it makes use of light and darkness. The process makes use of a new electric eye—a coated metal plate—that sees and remembers an image by static electricity, instead of by chemicals in present protographic films, which are chemical eyes. Printing the drawing is done simply with a dry powder and static electricity. No chemicals or liquids are used. Such images can be printed on paper, wood, cloth, metal, or other materials in black and white—or colors.

Xerography was demonstrated by Dr. R. M. Schaffert of the Battelle Memorial Institute, Columbus, Ohio, and Joseph C. Wilson, president of the Haloid Co. of Rochester, N. Y. Mr. Wilson said xerocopying machines are built to reproduce line work, like drawings, blueprints, and documents.

Battelle scientists also demonstrated a printing press based on the new methods. It produces 1,200 feet of printed copy a minute and uses only dry powder and electricity—with no inks, rollers, or heavy presses.

In the demonstration, the new electric eye took a picture and made a print of a line drawing in 45 seconds.—*The Washington Evening Star,* October 23, 1948.

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

THE PRACTICE OF TOWN PLANNING. John S. Gawler, *The Australian Surveyor,* December 1946-March 1947. (A discussion of town planning in Victoria, Australia, delivered before the Victorian Institute of Surveyors.)

ELECTRONICS IN HYDROGRAPHIC SURVEYING. Clarence A. Burmister, *The Journal, Coast and Geodetic Survey,* January 1948. (Discusses development and present status of electronic methods in the Coast and Geodetic Survey as used for position fixing in hydrographic surveying.)

LEVEL NET OF INDIA AND ITS DATUM. B. L. Gulatee, *India Central Board of Irrigation,* January 1948. (Discusses factors which affect selection of leveling datum in India, methods used, and accuracy of procedure.)

BOTTOM CONFIGURATION IN THE GULF OF MEXICO. George C. Mattison (with comment by P. A. Smith), *The Journal, Coast and Geodetic Survey,* January 1948. (Discussion and map illustrations based on hydrographic surveys made in 1940.)

TRIANGULATION: THE REDUCTION OF ANGLES AND STATION ADJUSTMENTS. H. F. Rainsford, *Empire Survey Review,* January 1948. (A discussion of methods employed in the recomputation of the Uganda main triangulation.)

PUNCHED-CARD METHODS FOR COMPUTING DISTANCES. Charles A. Whitten, *The Journal, Coast and Geodetic Survey,* January 1948. (Discusses procedures utilizing IBM machines to compute distances between 492 cities in the United States.)

FLARE TRIANGULATION BETWEEN FLORIDA AND THE BAHAMAS. Franklin R. Gossett, *The Journal, Coast and Geodetic Survey,* January 1948. (Describes operational procedure, method of computation, and results obtained in a project using flares dropped from airplanes.)

ACROSS THE EMPTY QUARTER. W. Thesiger, *The Geographical Journal,* January-March 1948. (An account of a journey through eastern Rub'al Khali, Southern Arabia, from October 1946 to February 1947.)

TOPOGRAPHY AND WEATHER IN THE ANTARCTIC. H. H. Lamb, *The Geographical Journal,* January-March 1948. (Observations by a representative of the British Air Ministry aboard the *Balaena* during the whaling season of 1946–47.)

PROCEEDINGS OF THE FORTY-FIRST ANNUAL MEETING OF THE CANADIAN INSTITUTE OF SURVEYING. *The Canadian Surveyor,* Special Edition, February 1948.

IMPROVED METHOD OF LAND SURVEYING FOR USE IN BRUSH-COVERED AREAS. K. H. Waters, *Geophysics,* April 1948. (Discusses use of odograph, adaptation of horizontal stadia method, and truck-mounted towers to elevate instruments.)

TRAINING OF LAND SURVEYORS. J. A. H. Church, *The Canadian Surveyor,* April 1948. (An explanation of the course of training given to veterans in the Canadian Vocational Training Survey course in Nova Scotia.)

THE UNIFICATION AND DEVELOPMENT OF LENGTH STANDARDS. R. H. Field, *The Canadian Surveyor,* April 1948.

FOREIGN TRAINED GEOGRAPHERS: THEIR PREPARATION AND JOB OPPORTUNITIES. Earl B. Shaw, *The Journal of Geography,* May 1948. (A brief outline of the educational facilities and job opportunities for geographers in Latin American countries.)

PRISM DEVICE ELIMINATES ONE MAN FROM SURVEYING PARTY. Serge A. Emery, *Civil Engineering,* May 1948.

THE EDUCATIONAL FUNCTIONS OF THE GEOGRAPHICAL SOCIETIES OF THE UNITED STATES. John K. Wright, *The Journal of Geography,* May 1948.

DETERMINATION OF POSITION AND AZIMUTH BY SIMPLE AND ACCURATE METHODS. J. C. Penn, P. E. Wylie, and P. V. H. Weems, *Proceedings, American Society of Civil Engineers,* June 1948.

REPORT OF COMMISSION I—PHOTOGRAPHY (to the Sixth International Photogrammetry Congress, The Hague, Netherlands, 1–10 September 1948). O. S. Reading and James J. Deeg, *Photogrammetric Engineering,* June 1948. (The report summarizes the achievements in photography for photogrammetry from 1938 to 1947 inclusive.)

OPTICAL THEODOLITE SPEEDS DAM SURVEY. C. O. Greenwood, Jr., *Engineering News-Record,* June 10, 1948. (Description of theodolite devised by H. Wild, Switzerland.)

REPORT ON THE AERIAL PHOTOGRAPHY OF THE RONNE ANTARCTIC RESEARCH EXPEDITION. William Robertson Latady, *Photogrammetric Engineering,* June 1948. (A report of the photographic operations during the expedition with emphasis upon the trimetrogon aerial mapping method for polar exploration and remote areas.)

SURVEYING WITH PULSED-LIGHT RADAR. W. W. Hansen, *Electronics,* July 1948. (Describes optical electronic instrument suited to survey of terrain when conventional methods would be too slow, or for long traverses over inaccessible terrain.)

RADAR FOR RIVER NAVIGATION. Kenneth E. Applegate, *The Military Engineer,* July 1948. (Emphasizes the development of special charts for use in navigation by radar on the Ohio River.)

RONNE ANTARCTIC RESEARCH EXPEDITION, 1946–1948. Finn Ronne, *The Geographical Review,* July 1948. (An account of the expedition to Antarctica which included exploration of Palmer Peninsula; also the unexplored Weddell Sea Coastline from Palmer Peninsula to Coats Land.)

THE AIRBORNE MAGNETOMETER AND ITS FUTURE USE IN CANADA. Virgil Kauffman, *The Canadian Surveyor,* July 1948. (An account of commercial operation of the airborne magnetometer in conducting mineral surveys.)

OHIO RIVER BASIN FLOOD CONTROL PLAN. Douglas L. Weart and J. W. Bruce, *The Military Engineer,* August 1948.

PROJECTED CONSTRUCTION PROGRAM DEVELOPS COLUMBIA RIVER BASIN FOR IRRIGATION. L. V. Downs, *Civil Engineering,* August 1948. (The location and extent of Columbia Basin Project and status of principal features.)

EXPLORING THE MID-ATLANTIC RIDGE. Maurice Ewing, *The National Geographic Magazine,* September 1948. (An account of the National Geographic Society—Woods Hole Oceanographic Institution—Columbia University Expeditions to the Mid-Atlantic Ridge.)

EXPLORACIONES EN COAHUILA Y NUEVO LEON. Dr. Federico K. G. Mullerried, *Boletin de la Sociedad Mexicana de Geografia y Estadistica.* (An account of geological explorations in the central region of the State of Coahuila and adjacent areas of Nuevo Leon, Mexico.)

BOOKS AND PAMPHLETS

PHOTOGRAMMETRIC CONTROL EXTENSION. Ralph O. Anderson. *Edwards Brothers, Inc.,* Ann Arbor, Michigan. 1947. 52 pages. $1.00. (Supplements *Applied Photogrammetry,* published in 1946 by the same author.)

CATALOGO ILLUSTRATO DELLE PUBBLICAZIONI. *Instituto Geografico Militare,* Firenze, Italy. 1947–1948. (The catalog contains many excellent examples, in color, of the various types of maps published in Italy.)

THE STEREOPLANIGRAPH AND THE COORDINATOGRAPH (Bulletin No. 27). *U. S. Army Map Service,* Washington, D. C. March 1948. 32 pages. (Describes characteristics of these Zeiss plotting instruments.)

THE COAST OF NORTHEAST GREENLAND (Special Publication No. 30). Louise A. Boyd. *American Geographical Society,* New York. 1948. 339 pages. (Deals with the work of the Louise A. Boyd Expeditions of 1937 and 1938 to the Northeast Coast of Greenland, including surveys of the Greenland Sea.)

LIMNOLOGICAL METHODS. Paul S. Welch. *The Blakiston Company,* Philadelphia. 1948. 381 pages. (A comprehensive discussion of numerous technical methods employed in the study of lakes, ponds, and streams with reference to hydrographical, physical, chemical, and biological conditions.)

ELEMENTS OF PHOTOGRAMMETRY. Earl Church and Alfred O. Quinn, *Syracuse University Press,* Syracuse, New York. 120 pages. $3.00.

ELEMENTS OF NOMOGRAPHY. Raymond D. Douglass and Douglas P. Adams. *McGraw-Hill Book Co.,* New York and London. 209 pages. $3.50. (Deals with the preparation and use of alignment charts, presenting seven elementary types.)

WHO'S WHO IN ENGINEERING. *Lewis Historical Publishing Co.,* New York. Sixth Edition. 2,357 pages. $15.00. (Biographical listing of engineers; includes list of national and local engineering organizations.)

ENGLISH FOR ENGINEERS. S. A. Harbarger, Anne B. Whitmer, and Robert Price. *McGraw-Hill Book Company,* New York. 1948. 226 pages. $2.25. (Suggestions to the engineer for reducing a problem to its fundamentals.)

INTERNATIONAL CIVIL AVIATION, 1945–1948. Paul A. Smith. *U. S. Government Printing Office,* Washington, D. C. 40 pages. (Report to the Secretary of State by the Representative of the United States to the International Civil Aviation Organization.)

HISTORICAL GEOGRAPHY OF THE UNITED STATES. Ralph H. Brown. *Harcourt, Brace & Co.,* New York. 1948. 596 pages. (The late Ralph Hall Brown presents with skill a mass of historical data.)

AERIAL PHOTOGRAPHY IN FORESTRY. Stephen H. Spurr. *The Ronald Press Co.,* New York. 1948. 340 pages.

DISTINCTIVE RECENT MAPS

Unique among the many world maps, which have appeared during the past several years, is the new reference map prepared by the American Geographical Society of New York for the United States Department of State and released early in 1948. The map has an equatorial scale of 1: 30,000,000, and is on the Miller cylindrical projection. While retaining the advantages of an uninterrupted map, this projection shows less north-south distortion in the high latitudes than does the familiar Mercator projection. The map is of a physical-political type with generalized relief shown by brown form lines and graduated layer tints in green and buff. Continental shelves are indicated in light blue, with dark blue for the ocean basins. The new world map measures 57 by 35 inches. Available with it is a diagram, with instructions, for use in determining distances and great circle routes.

Of interest to economists and economic geographers is a new economic map of Switzerland (Wirtschaftsgeographische Karte der Schweiz), prepared by Hans Carol, and published in 1946 by Kümmerly and Frey at Bern. It is at the scale of 1: 300,000 and measures 32 by 45 inches. Transportation and communications lines, hydroelectrical projects, agricultural and forest utilization, uncultivated areas, cities and towns, and industrial centers are indicated by color and symbol designations. Two inset maps (scale 1: 1,270,000) show the distribution of types of industries and the major economic regions of the country. The title and legends are given in French and German. A descriptive text of 60 pages accompanies the map.

Southern Palestine, Sheet 3 of a projected three-sheet Geological Map of Palestine (1947) is a notable contribution to the cartography and geology of the Near East. The map, an official Palestine publication, was compiled from various sources by Government Geologist S. H. Shaw. It is available through the Survey of Palestine at Jaffa, or the Geological Section, Public Works Department, Jerusalem. A 42-page booklet on the geology of Southern Palestine accompanies the map. The map, on the scale of 1: 250,000, covers the territory south of latitude 30°57′ N. The geological formations of adjacent areas of Egypt and Trans-Jordan are included. A number of fault lines are shown. The map is on a sheet 35 by 25 inches, and folds into a pocket on the inside back cover of the booklet.

The growth of the National Capital was an inevitable consequence of the wartime economy. This great expansion of the urban area of Washington is graphically shown on the new pocket map issued as a supplement to the September 1948 issue of the *National Geographic Magazine*. It comprises really two maps, printed on either side of a sheet 31¾ by 24¼ inches. The Pocket Map of Central Washington, on a scale of 4 inches to a mile, extends from American University on the northwest to the Franciscan Monastery on the northeast; and from Arlington Village on the southwest across Washington National Airport, to Fort Stanton Park on the southeast. It locates in detail virtually everything of interest in the city and the adjoining area of Virginia which includes Arlington National Cemetary, the Pentagon Building, and the National Airport. The companion map covers Suburban Washington on a scale of 1 inch to a mile. It shows strikingly the many new residential areas which have been developed in Virginia and Maryland during recent years. The suburban map extends beyond the Great Falls of the Potomac on the northwest, to the Patuxent Wildlife Refuge on the northeast, beyond Alexandria, Va., on the southwest, and past Andrews Air Force Base on the southeast.

Washington, District of Columbia, Your Nation's Capital is another new map of the city. It was prepared for free distribution by the District of Columbia Department of Highways Planning Survey, in cooperation with the Public Roads Administration, Federal Works Agency. Lithography is by the Army Map Service. One side of the sheet shows the Metropolitan Area of Washington, D. C., with the General Central Area of Washing-

ton on the verso. Half of the latter side is devoted to pictures and brief descriptive text of "Points of National Interest." Designed primarily as a highway map, it does not approach the detail shown on the National Geographic map of Washington.

An interesting and attractive series of pictorial maps of the Counties of England is currently in production by the Countryman Limited, 10 Bouverie Street, London, E. C. 4. The maps were planned "to set on record the achievements of the British countryside against the background of the war." They combine modern accuracy with the classical traditions of decorative cartography. In addition to portraying the principal geographic features the maps indicate the types of land utilization and make reference to local events of historical interest. Space outside the county limits are filled with heraldic decorations and quotations from speeches of Winston Churchill. The first maps of the series were published in 1945. The following counties are now available: Cambridgeshire, Derbyshire, Devonshire, Hampshire, Kent, Norfolk, Northern Ireland, Northumberland, Oxfordshire, Somerset, Sunex, and Wiltshire. The maps are on sheets measuring 23 by 18 inches. The scales vary, but for most of the maps approximate 1:300,000. The Countryman County Maps should have a particular appeal to collectors and genealogists, as well as to members of our Armed Forces who were stationed in Britain during the war.

—W. W. Ristow

Azimuthal Equidistant Projection Centered on London

One of the finest maps of the world drawn on an azimuthal equidistant projection centered on London is available at nominal cost as Admiralty Chart No. 5085 from the Hydrographic Department, Admiralty, London. Although the map is of particular value to radio engineers, meteorologists, and airmen, it is of great value in the classroom as a base to visualize air routes in and out of London. A straight line on this projection ruled from London to any point is the shortest route to that point, and can be computed from the scale expressed in either miles or kilometers. The scale is 1,000 statute miles to an inch. It usually comes as a surprise to see that the direct air route from London to Wellington, New Zealand, passes through Norway and near the Arctic coast of Siberia; that from London to San Francisco passes through Greenland and the northern part of Hudson Bay; and that from London to Singapore is through Holland and northern Germany.—*The Journal of Geography,* February 1948.

New Prints From the "Atlantic Neptune"

The Society has received from the British Admiralty, through H. M. Consul General in New York, the welcome gift of 34 plates of J. F. W. Des Barres's "Atlantic Neptune." These are new prints from the old copperplates executed for the use of the Royal Navy during the American Revolution. The charts cover the Atlantic and Gulf coasts of the United States, with detailed plates for Maine, Rhode Island, and several ports along the Atlantic coast and in western Florida. The Society owns an original three-volume edition of the "Atlantic Neptune," which is rich in colored plates. The new prints include two that do not appear in this set—Philadelphia, and Yorktown, Va. The prints also appear to be later states: the Society's originals are in the main outlines of the coast, with water-color washes inland; the prints are from plates that have been heavily stippled on all land areas.—*The Geographical Review,* April 1948.

Books in Review

ELEMENTS OF PHOTOGRAMMETRY. Earl Church and Alfred O. Quinn. *Syracuse University Press*, Syracuse, New York. 1948. 120 pages. $3.00.

Reviewed by WM. S. HIGGINSON, Photogrammetric Engineer, and H. J. MCMILLEN, Photogrammetrist, U. S. Geological Survey, Arlington, Virginia

THIS BOOK is a revision and enlargement of "Elements of Aerial Photogrammetry" by Earl Church, first published in 1944. It is intended to serve as a text for a college course in elementary photogrammetry. The subject matter is well organized, concisely stated, and clearly presented.

Part I covers the fundamental principles of the theory of photogrammetry. Subjects covered are: Definition of terms, history, development, present use, and future prospects; fundamental principles—definition of terms and elementary geometric principles; ground control surveys which relate to photogrammetric mapping; photographic interpretation; application of fundamental principles to practical problems. In this chapter all of the principles previously developed are applied to solve common problems. The presentation is clear, easy to understand, and the solutions derived with a minimum of computation. Such presentation, however, might lead to "cut and dried" substitution by students, rather than development of working knowledge in use of basic principles. The applicability of this criticism would depend entirely upon the manner in which the instructor conducted his lectures and the type of outside problems assigned.

Part II—Practical Mapping Methods. This part serves to introduce the student to the practical operations, techniques, and procedures for some of the common methods of map compilation in present use. Since the material is brief, it is presumed that the instructor will fill in the necessary details from his personal knowledge.

The publication is of interest to the professional photogrammetrist, not as a handbook or reference for the solution of unusual problems, but as a textbook for students, as the author intended. As such, it will give the employer of photogrammetrists a proper insight into the instruction in photogrammetry which is being given by some of our colleges and universities, and inform him of the background which graduating students will have when entering into professional employment. Professors Church and Quinn are to be commended for fitting this text to the practical needs of employers of the profession.

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New Manuals on Astronomy and Leveling

TWO RECENT PUBLICATIONS of the U. S. Coast and Geodetic Survey, of interest to surveyors, are now available at the *U. S. Government Printing Office,* Washington 25, D. C.

The first is an instruction manual and guide for making precise astronomical determinations of latitude, longitude, and azimuth in connection with geodetic horizontal control surveys. The manual describes in detail the latest methods in use and instruments employed in determining precise latitude, longitude, and azimuth. The method of azimuth observations with the Bamberg broken telescope transit set in a vertical plane containing polaris and the azimuth mark is described. There is included a special table for the astronomical refraction; also included are tables required for the reduction of astronomical observations. The new manual is designated "Special Publication No. 237, Manual of Geodetic Astronomy," and may be obtained for $1.00 per copy.

The second is Special Publication No. 239, Manual of Geodetic Leveling. This is an

expansion and extensive revision of Part I of Special Publication No. 140, Manual of First-Order Leveling, and is available at 40 cents per copy. In addition to general instructions for the guidance of geodetic leveling parties, the new manual describes various instruments used in leveling surveys, the establishment and descriptions of bench marks, field records, and field computations. The river-crossing method for carrying levels over rivers where no suitable bridges are available is also discussed in detail.

Instructions to recovery-and-stamping parties engaged in maintenance work on the system of bench marks established by the Coast and Geodetic Survey are a new feature of the manual. It is intended primarily for the use of geodetic leveling parties of the Coast and Geodetic Survey but can be used effectively as a guide for field practice by any individual or organization desiring to engage in leveling of precision.

—A. A. STANLEY

Bibliography on Highway Planning Data Available

To make effective use of highway planning data obtained since the inception of the program of State-wide Planning Surveys, the library staffs of the Federal Works Agency and the Public Roads Administration have compiled an annotated and indexed bibliography for the Committee on "Uses of Highway Planning Survey Data." This material, incorporating comments from the planning survey sections of the various state highway departments, has been made available as Bibliography No. 4 of the Highway Research Board. Inquiries should be addressed to the Board, 2101 Constitution Avenue, Washington 25, D. C.

Uses that have been made of the survey data, listed in the bibliography, include: Maps to show the state of the existing facility and the traffic service performed; origin and destination data to show desired directions of traffic flow; fiscal studies to determine the proper division of funds among administrative systems; motor-vehicle allocation studies to furnish information for a highway tax policy; road-life studies to obtain data for the analysis of annual highway costs; and the combination of the foregoing data to be used in determining the economic justification of project priority.—*Civil Engineering,* August 1948.

The National Grid and Reference System

THE NATIONAL GRID now being shown on all the later maps and plans of the Ordnance Survey provides a unique reference system by which the position on the map of any point in Great Britain can be specified clearly and without ambiguity. It would be a great advantage to all concerned if the system were more generally known and more extensively used. The system is described in a small pamphlet of eleven pages, entitled "A Brief Description of the National Grid and Reference System," which has recently been produced by the Ordnance Survey and is published by H.M.S.O. at the price of fourpence.

The pamphlet describes very briefly, but with great clarity, what the grid is, the reason why it has been introduced and its relation to the Principal Triangulation and to the map, and it also gives very clear descriptions and examples of the system of map references as applied to maps on each of the different scales. It should be of the greatest value to all map users and to students of geography, and, as a means of popularizing a more general use of map references.—*Empire Survey Review,* January 1947.

CONGRESS NEWS

Activities of Control Surveys Division

Captain H. W. Hemple, Chairman of the Technical Division of Control Surveys, has appointed the following members to a Committee on Highway Surveys:

J. C. CARPENTER, Highway Engineer, Public Roads Administration, *Chairman*
JON S. BEAZLEY, Assistant Engineer, State Road Department of Florida
R. GETTY BROWNING, Chief Locating Engineer, North Carolina State Highway Department
CHARLES W. GREENGARD, Cook County Highway Department, Illinois
FRED GRUMM, Deputy State Highway Engineer, California Department of Public Works, Sacramento, California
E. C. HOUDLETTE, Director of Survey Division, Department of Public Works, Commonwealth of Massachusetts
ALLAN LEE, Engineer of Road Design, Maryland State Roads Commission
LLOYD J. MORRISON, Highway Engineer, Public Roads Administration, Ogden, Utah
WILLIAM PRYOR, Highway Engineer, Public Roads Administration, Washington, D. C.

The objective of this Committee will be the development of policies for surveys to provide control along highways. It is contemplated that standards for highway surveys from the control survey viewpoint will be compiled and eventually submitted to the Congress for adoption. These standards would be recommended to the various state and county highway departments for use on all surveys and particularly on those for the most important highway routes. It is expected that an effective program will be adopted by this Committee.

Activities of Cartography Division

The Committee elected at the Annual Meeting of the Technical Division on Cartography to direct the organization, meetings, and programs for the year 1948–9 have held two recent meetings, on August 31st and September 13th, for the purpose of completing the organization of the Division. Chairman W. C. Crump, of the Hydrographic Office, presided.

At these two meetings the most important accomplishment was the completion of the organization of the Division, and this resulted in the election or appointment of the following officers and committees:

Officers

ROBERT J. VOSKUIL, *Vice-Chairman;* MAURICE S. A. DELANEY, Hydrographic Office, *Secretary-Treasurer;* ARTHUR F. STRIKER, U. S. Geological Survey, *Associate Editor.*

Committee

GORDON B. LITTLEPAGE, U. S. Coast and Geodetic Survey; ROBERT J. VOSKUIL; C. E. RIDDIFORD, National Geographic Society; OSCAR H. NELSON, U. S. Geological Survey; L. A. BLUM, Aeronautical Chart Service; B. D. PRICE, Army Map Service.

Subcommittees

PROGRAM COMMITTEE

PAUL ALEXANDER, Army Map Service, *Chairman*
B. D. PRICE, Army Map Service
BRADFORD P. TAYLOR, U. S. Geological Survey
RALPH M. BERRY, U. S. Coast and Geodetic Survey

MEMBERSHIP COMMITTEE

LESTER TRUEBLOOD, Military Intelligence, G-2, Pentagon, *Chairman*
CHARLES R. GRAHAM, U. S. Geological Survey
MARGARET M. KINGMAN
F. J. ORTIZ, U. S. Coast and Geodetic Survey
IRWIN RAISZ, 2 Divinity Ave., Cambridge, Mass.

RESEARCH AND DEVELOPMENT COMMITTEE

NEWMAN BUMSTEAD, National Geographic Society, *Chairman*
SAMUEL SACHS, U. S. Coast and Geodetic Survey
CHAS. F. FUECHSEL, U. S. Geological Survey
NORMAN E. GREENAWALT
JOHN H. KELLEY, Army Engineers, Fort Belvoir, Va.

TECHNICAL STANDARDS COMMITTEE

JOHN R. DICKENS, Hydrographic Office, *Chairman*
J. S. WEIRICH, U. S. Coast and Geodetic Survey
LIONEL C. MOORE, U. S. Geological Survey
G. F. TISE, Aeronautical Chart Service

It was voted that the Executive Committee would consist of the Chairman, Vice-Chairman, Secretary-Treasurer, Associate Editor, the six members of the Committee, and the Chairmen of all subcommittees.

The Chairmen of all subcommittees are free to select additional members for their respective committees.

The Program Committee hopes to arrange several meetings this winter where some interesting papers will be heard and ideas exchanged, and it hopes that all members of the Congress who are interested in this Division will send their ideas and suggestions as to topics and procedures.

M. S. A. DELANEY,
Secretary-Treasurer

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